SOIL SURVEY OF

Howard County, Iowa

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Iowa Agriculture and Home Economics Experiment Station
Cooperative Extension Service, Iowa State University and the
Department of Soil Conservation, State of Iowa

Issued December 1974

Major fieldwork for this soil survey was done in the period 1962–67. Soil names and descriptions were approved in 1969. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1968. This survey was made cooperatively by the Soil Conservation Service, Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Howard County Soil Conservation District.

Copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All of the soils of Howard County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county by map symbol and gives the capability classification and woodland suitability group of each. It also shows the page where each soil is described and the page for the capability unit and woodland suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability groups.

Foresters and others can refer to the section "Use of the Soils for Woodland," where the soils of the county are grouped according to their suitability for trees.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Howard County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County."

Cover: **Typical landscape in the Basset-Clyde-Schley association. Tile outlets and grassed back slopes of terraces have just been completed.**

Contents

Issued December 1974

This page intentionally left blank.

SOIL SURVEY OF HOWARD COUNTY, IOWA

BY RUSSELL L. BUCKNER AND JOHN D. HIGHLAND, SOIL CONSERVATION SERVICE

FIELDWORK BY RUSSELL L. BUCKNER, MELVIN D. BROWN, EDWARD L. BRUNS, AND KERMIT D. VOY, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY, AND THE DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

HOWARD COUNTY is near the northeast corner of Iowa (fig. 1). It has an area of 301,440 acres. Cresco, the county seat, is on the eastern edge of the county.

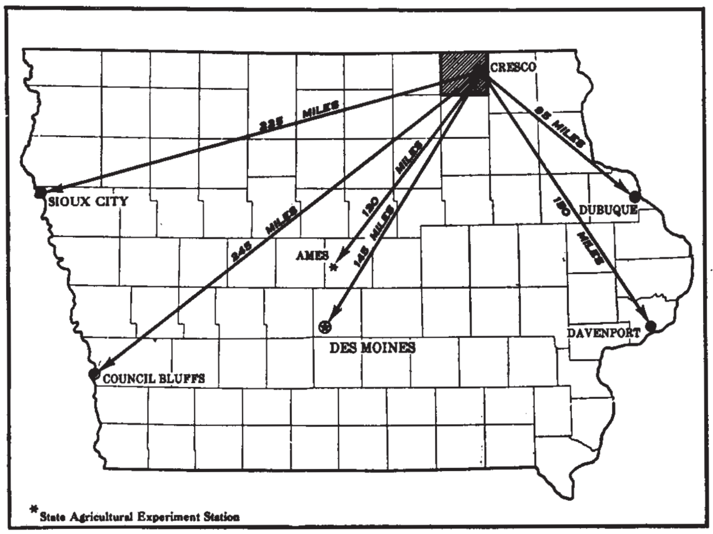


Figure 1.—**Location of Howard County in Iowa.**

Howard County is rural. The principal crops are corn, soybeans, oats, hay, and pasture. Except for soybeans, most of the crops produced are fed to livestock. Beef cattle, hogs, and dairy products are the principal sources of income.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Howard County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures (*9*).[1] The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Cresco and Fayette, for example, are the names of two soil series. All of the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soil of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Downs silt loam, 5 to 9 percent slopes, is one of several phases within the Downs series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

---

[1] Italic numbers in parentheses refer to Literature Cited, p. 130.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units shown on the soil map of Howard County are soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Clyde-Floyd complex, 1 to 4 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Radford and Huntsville silt loams, 2 to 5 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Marsh is a land type in Howard County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all of the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Howard County. A soil association is a landscape that has a distinctive pattern of soils. It normally consists of two or more major soils and a few minor soils, and it is named for the major soils. The soils in one association may be in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The seven soil associations in Howard County are described in this section of the survey.

1. Cresco-Clyde-Protivin association

Nearly level to gently sloping, moderately well drained to poorly drained, loamy soils on uplands

This association is on uplands and is characterized by long, gentle slopes, slightly rounded hills, a well-developed drainage network, and soils in which the subsoil re-

***Figure 2.*—Typical landscape in association 1. A tile line is being installed in the Clyde soils.**

stricts drainage. A large part of this association is east of and within about 6 miles of Crane Creek. A typical area is west of Davis Corners along Iowa Highway 9 (fig. 2).

Most of this association, except for the Clyde soils, formed in 13 to 24 inches of loamy overburden and underlying very firm glacial till. A band of pebbles or concentration of small stones separates the loamy overburden from the till. Water moves more rapidly through the overburden than through the till. As a consequence, water accumulates at the contact surface between these two materials and then moves downward along the line of contact. In some places it emerges part way down the slope as a seep spot, and in other places it wets a large part of the slope. Tile lines can be installed to improve drainage.

This association occupies about 15 percent of the county. Cresco soils make up about 20 percent of the association; Clyde soils, about 19 percent; Protivin soils, about 16 percent; and minor soils, the remaining 45 percent (fig. 3).

The Cresco soils are gently sloping and moderately well drained. They have a surface layer of thick, black and very dark grayish-brown, loamy material and a brown subsoil that grades to mottled, strong-brown, yellowish-brown, and gray, very firm clay loam. These soils are on convex ridgetops and sides of ridges.

The Clyde soils are poorly drained. They have a thick surface layer of black and very dark gray silty clay loam and a subsoil of mottled, yellowish-brown and grayish-brown, stratified, loamy material. They are in and adjacent to most of the nearly level drainageways and intermittent streams in the association. Some areas of Clyde soils occupy sloughs. Some are in permanent pasture. Fences generally parallel the boundaries of these areas. Stones and boulders that interfere with cultivation and with installation of tile are in many places.

The Protivin soils are gently sloping and somewhat poorly drained. They have a surface layer of thick, black and very dark gray, loamy material and a subsoil mainly of mottled, gray, strong-brown, and yellowish-brown, very firm clay loam. These soils are on broad ridgetops and on the lower sides of ridges below the Cresco soils.

Minor soils include soils of the Riceville, Lourdes, Floyd, and Schley series. These soils make up about 25 percent of this association. Riceville soils are similar to Protivin soils and occupy similar positions on the landscape, but their surface layer is thinner and not so dark colored. Lourdes soils occupy similar positions on the landscape to Cresco soils, but they have a thinner and less dark-colored surface layer. The somewhat poorly drained Floyd and Schley soils are generally adjacent to Clyde soils. Floyd soils have a thick surface layer of black and very dark grayish-brown loam and a subsoil of stratified, loamy material. Schley soils have a relatively thin surface layer of dark-colored loam and a subsoil of stratified, loamy material. Among the other minor soils are soils of the Jameston, Bassett, Donnan, Kenyon, Ostrander, and Tripoli series.

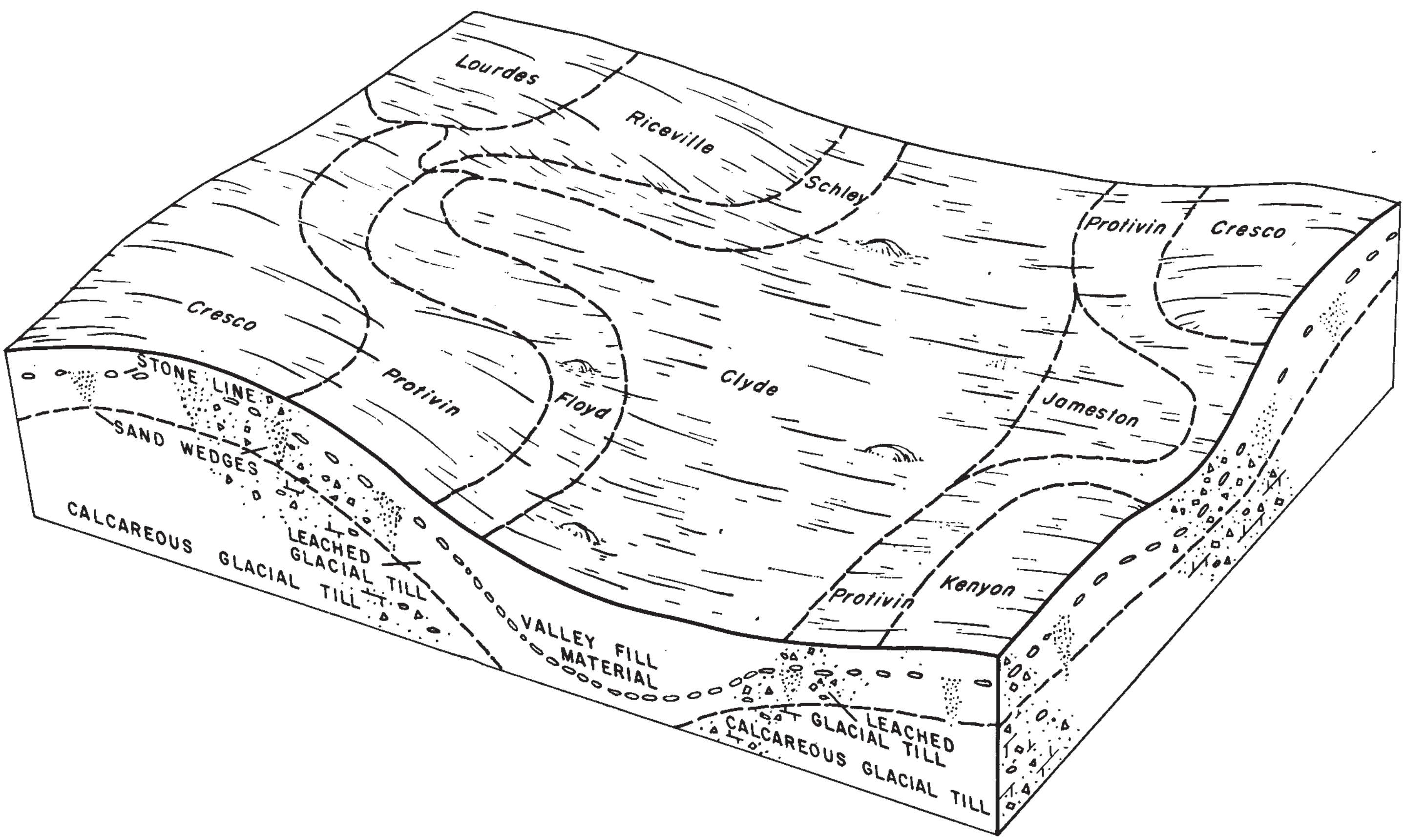


Figure 3.—**Relationship of soils and underlying materials in association 1.**

The soils of this association are mostly used for cultivated crops, but a few areas are in permanent pasture. With proper management this association is well suited to row crops.

The principal management needs are improvement of drainage, general improvement of fertility, and control of erosion. Artificial drainage is less effective than in other associations, because most of the soils are slowly permeable. Providing adequate drainage and at the same time controlling erosion is difficult, because these two measures conflict to some extent. The long upland slopes are well suited to contouring and terracing, but these practices slow down the movement of surface water and let more of it soak into the soil. The extra water that enters the soil on upper slopes seeps out on lower slopes and complicates drainage, especially in wet years. A combination of tile lines and terraces can be used to improve drainage.

2. Clyde-Floyd-Schley association

Nearly level to gently sloping, somewhat poorly drained and poorly drained, loamy soils on uplands

This association is on uplands that are characterized by broad ridges and broad, poorly drained areas along waterways. A typical area of this association occurs north of Davis Corners along U.S. Highway No. 63 (fig. 4).

Most of the soils of this association formed in a loamy overburden and the underlying stratified materials and glacial till. The drainage ranges from somewhat poor to poor, but it could be improved in many places by properly installed tile lines.

This association occupies about 12 percent of the county. Clyde soils make up about 25 percent of the association; Floyd soils, about 20 percent; Schley soils, about 15 percent; and minor soils, the remaining 40 percent.

Clyde soils are nearly level and poorly drained. They have a surface layer of thick, black and very dark gray silty clay loam and a stratified subsoil of mottled, yellowish-brown and grayish-brown, loamy material. Clyde soils are in broad areas along waterways. They are wet, at least in part, because of the high water table and seepage from higher lying soils.

Floyd soils are nearly level to gently sloping and are somewhat poorly drained. They have a surface layer of thick, black and very dark grayish-brown, loamy material and a mottled, yellowish-brown, strong-brown and grayish-brown, stratified subsoil. Floyd soils are on the broad tops of the lower sides of ridges. Some of these ridges appear as slightly raised areas and are surrounded by the Clyde soils.

Schley soils are nearly level to gently sloping and are somewhat poorly drained. They have a surface layer of relatively thin, dark-colored, loamy material over grayish-brown layers. The subsoil is mottled grayish-brown and strong-brown, stratified, loamy material. Schley soils also are on the broad tops and the lower sides of ridges. Some of these ridges appear as slightly raised areas and are surrounded by Clyde soils.

Minor soils include nearly level to gently sloping Oran soils that are similar to Schley soils but lack stratification in the subsoil. These soils make up about 10 percent of this association. Generally, they are on the upper part of broad ridges. About 30 percent of the association consists of small areas of the better drained Bassett, Cresco, Donnan, Kenyon, Ostrander, and Racine soils on the more distinct and narrow ridges.

Most of the soils in this association are well suited to, and are used mostly for, cultivated crops. Only a few areas have been left in permanent pasture.

Although much of this association has been drained, improvement of drainage is still the principal management need. Wetness of the Floyd, Clyde, and Schley soils

Figure 4.—**Typical landscape in soil association 2. Clyde soils are in the wide waterway, and Floyd and Schley soils are on the sides.**

is a result, at least in part, of hillside seepage. In such places, interceptor tile laid upslope from the wet spots is needed for drainage. This association also needs general improvement of soil fertility.

3. *Kenyon-Clyde-Floyd association*

Nearly level to moderately sloping, dark-colored, moderately well drained to poorly drained, loamy soils on uplands

This association is on uplands and is characterized by long, gentle slopes, slightly rounded hills, and a well-developed network of drainageways. In some areas, the hillsides are moderately sloping and slopes are shorter. A typical area of this association occurs north of Elma in the southwestern part of the county.

This association has a rectangular pattern of fields and roads. Most of the trees are in groves or windbreaks near farm buildings. A large part of the association is cultivated, but many areas are in permanent pasture. The areas of permanent pasture generally follow the winding swales and are fenced. Granite boulders are in most of the swales. Many of these boulders are very large and are a conspicuous feature of the landscape.

The soils of this association formed in a loamy overburden and the underlying glacial till. Water moves more rapidly in the loamy overburden than in the till. As a consequence, water accumulates at the contact surface between these two materials and then moves downward along the line of contact. It may emerge part way down the slope as a seepy spot, or it may wet a large part of the slope.

This association occupies about 19 percent of the county. Kenyon soils make up about 20 percent of the association; Clyde soils, about 20 percent; Floyd soils, about 12 percent; and minor soils, the remaining 48 percent (fig. 5).

The Kenyon soils are gently sloping to moderately sloping and are moderately well drained. They have a surface layer of thick, black and dark-brown loam and a subsoil that is yellowish brown and loamy. They are on the tops and sides of ridges.

Clyde soils are nearly level and poorly drained. They have a surface layer of thick, black and very dark gray silty clay loam and a stratified subsoil of mottled, yellowish-brown and grayish-brown, loamy material. Clyde soils are adjacent to most of the drainageways and intermittent streams and also occupy some of the lower sides of ridges. Some areas of Clyde soils are in undrained areas of permanent pasture and in sloughs. Stones and boulders that interfere with cultivation and with installation of tile are in many of these areas.

Floyd soils are nearly level to gently sloping and somewhat poorly drained. They have a thick, loamy surface layer that is black and very dark grayish brown. Their subsoil is stratified and is mottled yellowish brown, strong brown, and grayish brown. They mainly occupy concave areas downslope.

Of the minor soils, Ostrander and Readlyn are the most extensive. The well-drained Ostrander soils make up

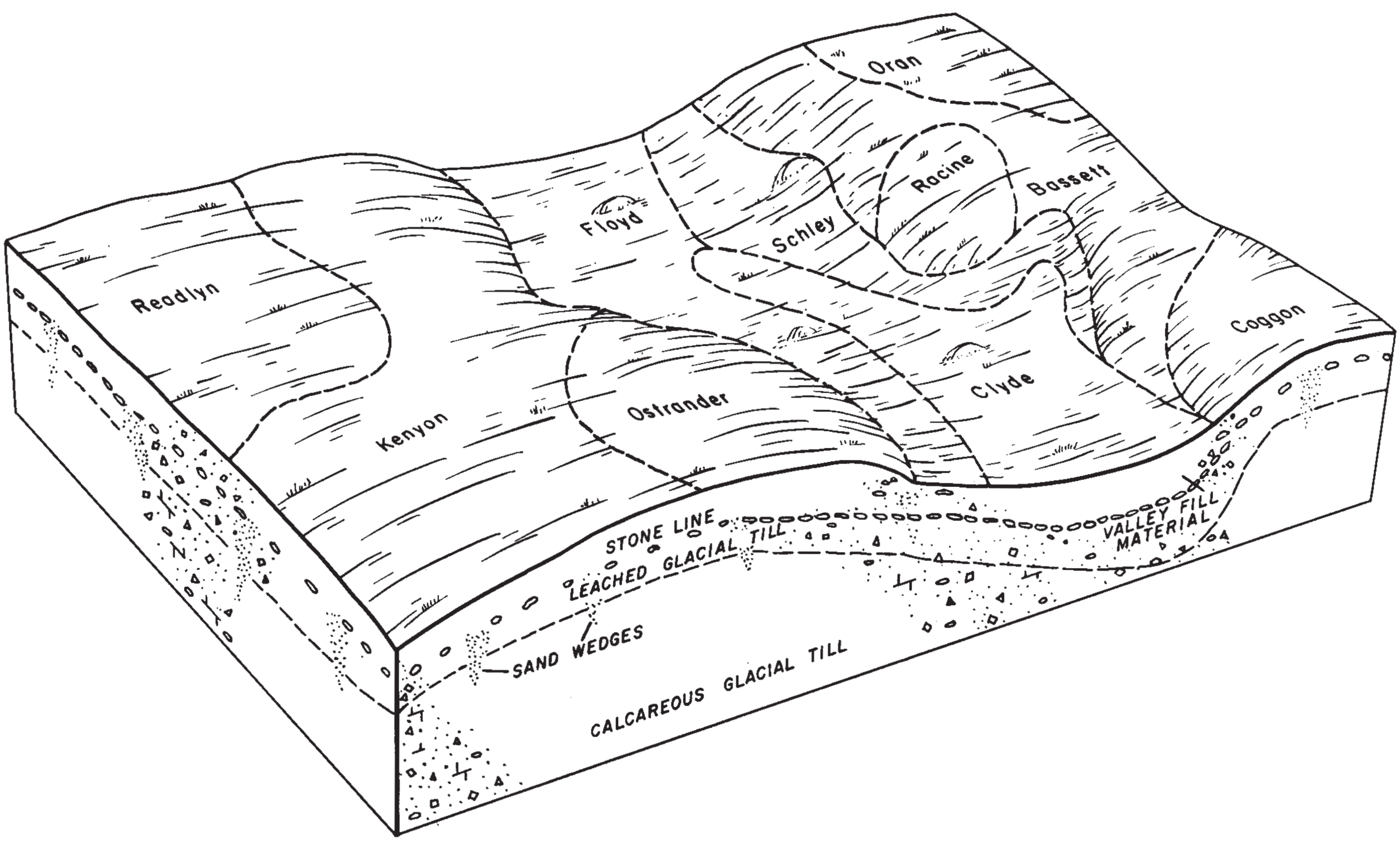


Figure 5.—**Relationship of soils and underlying materials in association 3.**

about 8 percent of this association. They are well drained and occur on the lower part of many of the narrow, convex sides of ridges. The somewhat poorly drained, gently sloping, dark-colored Readlyn soils are important in the western part of the county. They are on broad ridgetops and slightly convex sides of ridges. The other minor soils are chiefly the Bassett, Cresco, Oran, Protivin, Racine, Saude, Schley, Tripoli, and Wapsie soils.

The soils of this association are mostly used for cultivated crops. A few undrained areas are used for permanent pasture. With proper management, all of these soils are well suited to row crops.

The principal management needs are improvement of drainage, control of erosion, and general improvement of fertility. The wetness of Clyde and Floyd soils is caused partly by hillside seepage. Interceptor tile laid upslope from these wet areas is needed. It is difficult to provide adequate drainage and control erosion at the same time, because these two measures conflict to some extent. Using a combination of terracing and tile drainage helps to alleviate this difficulty.

4. *Bassett-Clyde-Schley association*

Nearly level to moderately sloping, moderately dark colored, moderately well drained to poorly drained, loamy soils on uplands

This association is characterized by long, gentle slopes, slightly rounded hills, and a well-developed drainage network. In some areas the side slopes are moderately sloping and shorter. A large part of the association is in areas that border major streams. A typical area of this association is just south of the town of Chester in the northern part of the county.

The soils of this association formed in a loamy overburden and the underlying glacial till or stratified material and till. The color and thickness of the surface layer are variable, but in most areas the soils have a thin, light-colored surface layer. Drainage ranges from good to poor, and much of it could be improved through the use of properly installed tile lines.

This association occupies about 23 percent of the county. Bassett soils make up about 20 percent of the association; Clyde soils, 20 percent; Schley soils, 10 percent; and minor soils, the remaining 50 percent.

The Bassett soils are gently sloping to moderately sloping and are moderately well drained. They have a relatively thin surface layer of dark-colored, loamy material. The subsoil is mottled, yellowish-brown loam. Bassett soils are on the tops and sides of ridges.

The Clyde soils are nearly level to moderately sloping and are poorly drained. They have a thick, loamy surface layer of black and very dark gray and a stratified, loamy subsoil of mottled grayish brown. Clyde soils are in and adjacent to most of the drainageways and intermittent streams and on some of the lower side slopes. Some Clyde soils are in permanent pasture, and sloughs and fences typically parallel their boundaries. Many areas of the permanent pasture contain stones and boulders that interfere with cultivation and with installation of tile.

The Schley soils are slightly convex to concave and somewhat poorly drained. They have a relatively thin surface layer of dark-colored, loamy material and a subsurface layer of dark grayish-brown, loamy material. The subsoil is mottled, grayish-brown and strong brown, stratified, loamy material. Schley soils generally are in downslope areas and in coves. They are wet, at least in part, because of seepage from soils in higher areas.

Minor soils include gently sloping to slightly convex Oran soils that are similar to Schley soils but lack the stratification in their subsoil. These soils make up about 7 percent of this association. They are on the broad tops and the slightly convex sides of ridges. About 5 percent of the association is made up of Racine soils that are similar to Bassett soils but are well drained. They are in positions similar to those of Bassett soils. Other minor soils are Coggon, Floyd, Kenyon, Lourdes, Pinicon, Renova, Riceville, Saude, and Wapsie soils.

Most of the soils of this association are used for cultivated crops, but a few areas are in permanent pasture or stands of timber. With good management this association is well suited to row crops.

The principal management needs are drainage, control of erosion, and general improvement of fertility. It is difficult to provide adequate drainage and to control erosion at the same time, because these two measures conflict to some extent. Using a combination of terracing and tile drainage alleviates this difficulty.

5. *Downs-Fayette association*

Gently sloping to steep, well-drained, loamy soils on uplands

This association is on uplands and is characterized by gently sloping and moderately sloping ridgetops and moderately sloping to steep sides of ridges and narrow valleys. There generally is a sharp break to the Upper Iowa River bottoms that consists of numerous limestone escarpments (fig. 6). This association occurs only in the extreme northeastern part of the county and includes what is locally known as the Golden Ridge.

This association is more rolling and hilly than most of the rest of the county, especially near the Upper Iowa River. Trees are scattered along roads, fence lines, and drainageways and are in groves and around farmsteads. Most farmsteads are on ridgetops, although a few are in small valleys. Fields are commonly small, and they have a variety of shapes. Patches of oak-hickory forest remain from the original vegetation. These patches and the wide distribution of trees are distinctive features of the landscape.

The soils in this association formed in deep loess. The surface layer of the Downs and Fayette soils is relatively thinner and lighter colored than that of many soils in the county. This is primarily because of the greater influence of trees and the greater amount of erosion in areas of the more sloping soils.

This association occupies about 4 percent of the county. The Downs soils make up about 65 percent of the association; Fayette soils, about 8 percent; and minor soils, about 27 percent (fig. 7).

The Downs soils are gently sloping to moderately steep. They have a thin surface layer of very dark grayish-brown, silty material and a subsoil of dark yellowish-brown and yellowish-brown, silty material.

The Fayette soils are moderately sloping to steep. They have a very thin surface layer of dark-colored, silty ma-

terial and a subsurface layer of lighter colored silt loam. The subsoil is dark yellowish-brown light silty clay loam that grades to silt loam with depth. Fayette soils are not very extensive and generally are confined to areas of timber.

Minor soils in this association are Sogn, Radford, Huntsville, and Port Byron soils. The Sogn soils are less than 15 inches thick over limestone bedrock, and in some places the limestone bedrock outcrops. They are on sharp breaks to drainageways (fig. 8) in many places. Sogn soils make up about 5 percent of this association. Most of the narrow valleys contain the Radford and Huntsville soils, which formed in deep, moderately dark and dark, silty and, in places, stratified alluvium. These soils make up about 5 percent of the association. Port Byron soils are gently sloping on ridgetops and moderately sloping in swales on the sides of ridges. They make up about 7 percent of the association. About 10 percent of this association is the Racine, Winneshiek, and a few sandy soils.

Except for areas where slopes are too steep, a large part of this association is used for, and is well suited to, cultivated crops. This association is one of the higher producing areas in the county. The steeper slopes generally are used for timber or permanent pasture.

The principal management need is the control of erosion resulting from the steep slopes and the erodibility of the soils. General improvement of fertility is also needed.

6. Rockton-Winneshiek association

Nearly level to steep, well-drained, moderately deep and deep, loamy soils on uplands

This association consists of nearly level to steep, well-drained soils that are underlain by limestone bedrock on uplands. It is only in the northeastern one-third of the county. Typical examples of this area are around Cresco and north of Lime Springs (fig. 9).

The soils of this association formed in loamy materials over limestone bedrock. To the north and west of Cresco and near Bonair the soils generally have a thicker and darker surface layer than the soils in other parts of the association. These soils do not require tile drainage as do soils in other associations of the county.

This association occupies about 10 percent of the county. Rockton soils that are moderately deep make up about 27 percent of the association; Rockton soils that are deep, about 20 percent; Winneshiek soils, 15 percent; and minor soils, the remaining 38 percent (fig. 10).

***Figure 6.*—Limestone escarpment along the Upper Iowa River. This is typical of the many areas in association 5.**

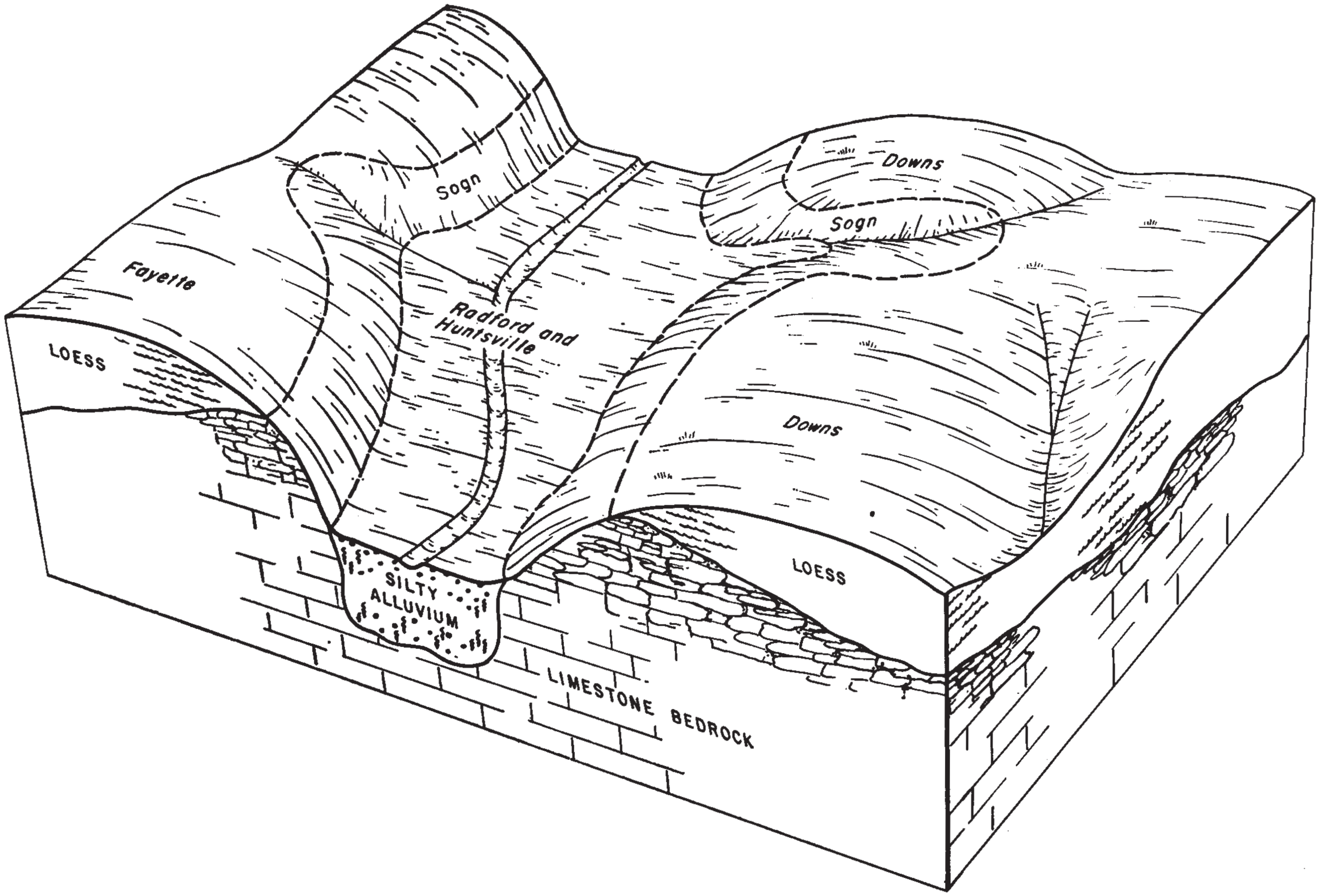


Figure 7.—**Relationship of soils and underlying materials in association 5.**

The moderately deep Rockton soils are nearly level to moderately sloping. They have a thick surface layer of black to dark-brown loamy material and a subsoil of dark yellowish-brown clay loam. Limestone is at a depth of 20 to 30 inches. These soils are on broad tops and sides of ridges.

The deep Rockton soils are nearly level to moderately sloping. They have a thick surface layer of dark, loamy material and a subsoil of dark yellowish-brown loam. Limestone bedrock is at a depth of 30 to 40 inches. The less sloping areas of these soils are on broad ridgetops, but some moderately sloping areas are on the lower sides of ridges.

The moderately deep Winneshiek soils are gently sloping on ridgetops and gently sloping to strongly sloping on the sides of ridges. They have a relatively thin surface layer of black and dark grayish brown, loamy material and a subsoil of dark yellowish-brown loam and clay loam. Limestone bedrock is at a depth of 20 to 30 inches. These soils are covered by trees in some areas.

Important minor soils in this association are the Terril and Sogn soils and the deep Winneshiek soils. Terril soils are nearly level to gently sloping. They are deep, dark, loamy soils that formed in local alluvium. They generally are in long, narrow strips adjacent to nearly every drainageway in the association. Terril soils make up about 5 percent of the association. The deep Winneshiek soils, which make up about 12 percent of the association, have

Figure 8.—**Deep-cutting gully in Radford and Huntsville soils. The Downs soils are in the background, and the shallow Sogn soils are on the right.**

a relatively thin, dark, loamy surface layer over a loamy subsoil. Limestone bedrock is at a depth of 30 to 40 inches. These soils are in positions on the landscape similar to those of the moderately deep Winneshiek soils. Sogn soils, which make up about 8 percent of the association, have limestone bedrock within 15 inches of the surface. In places the bedrock is exposed. Sogn soils are gently sloping and moderately sloping and are the steepest soils in the association. Some of the other minor soils are the Backbone, Dickinson, Lamont, Ostrander, Racine, Spillville, and Whalan soils. They make up about 13 percent of the association.

Most of this association is used for cultivated crops and is well suited to this use. Where the landscape is steep and broken, or where there are numerous rock outcrops, the area generally is in stands of timber or in permanent pasture. Potential production is extremely variable. The Terril soils and the nearly level, deep Rockton and Winneshiek soils are among the most productive in the county. On the steeper slopes, where limestone is close to the surface, production is lower and the distribution of rainfall is important for satisfactory production.

The principal management needs are the control of erosion and the general improvement of fertility. Shallow depth to limestone bedrock may hinder the application of conservation practices.

7. *Saude-Wapsie-Marshan association*

Level to gently sloping, well-drained and poorly drained, loamy soils on bottom lands and stream benches

This association is dominantly level, but it is gently sloping in some areas. In a few places along the bench escarpments, it is strongly sloping to steep. The soils on bottom lands and the soils on benches are impractical to separate because of their intermingled pattern and the generally narrow stream valleys. Many of the soils on bottom lands are subject to frequent flooding, but those on the benches are commonly free of flooding except in some low-lying areas. A typical area of this association occurs along Crane Creek south of the town of Lourdes.

This association occupies about 17 percent of the county. Saude soils make up about 20 percent of the association; Wapsie soils, about 18 percent; Marshan soils, about 15 percent; and minor soils, the remaining 47 percent (fig. 11).

The Saude soils are nearly level to gently sloping soils in broad areas on stream benches and on the sides of ridges and escarpments. They have a thick surface layer of black and very dark brown loamy material and a subsoil of dark yellowish-brown loam. Sand and some gravel are below a depth of 20 to 36 inches. The general position of Saude soils is somewhat higher than that of the associated Marshan and Lawler soils.

***Figure 9.*—Typical landscape in association 6. Sogn soils are in the foreground; Rockton soils, in the background; and Terril soils, in the drainageway.**

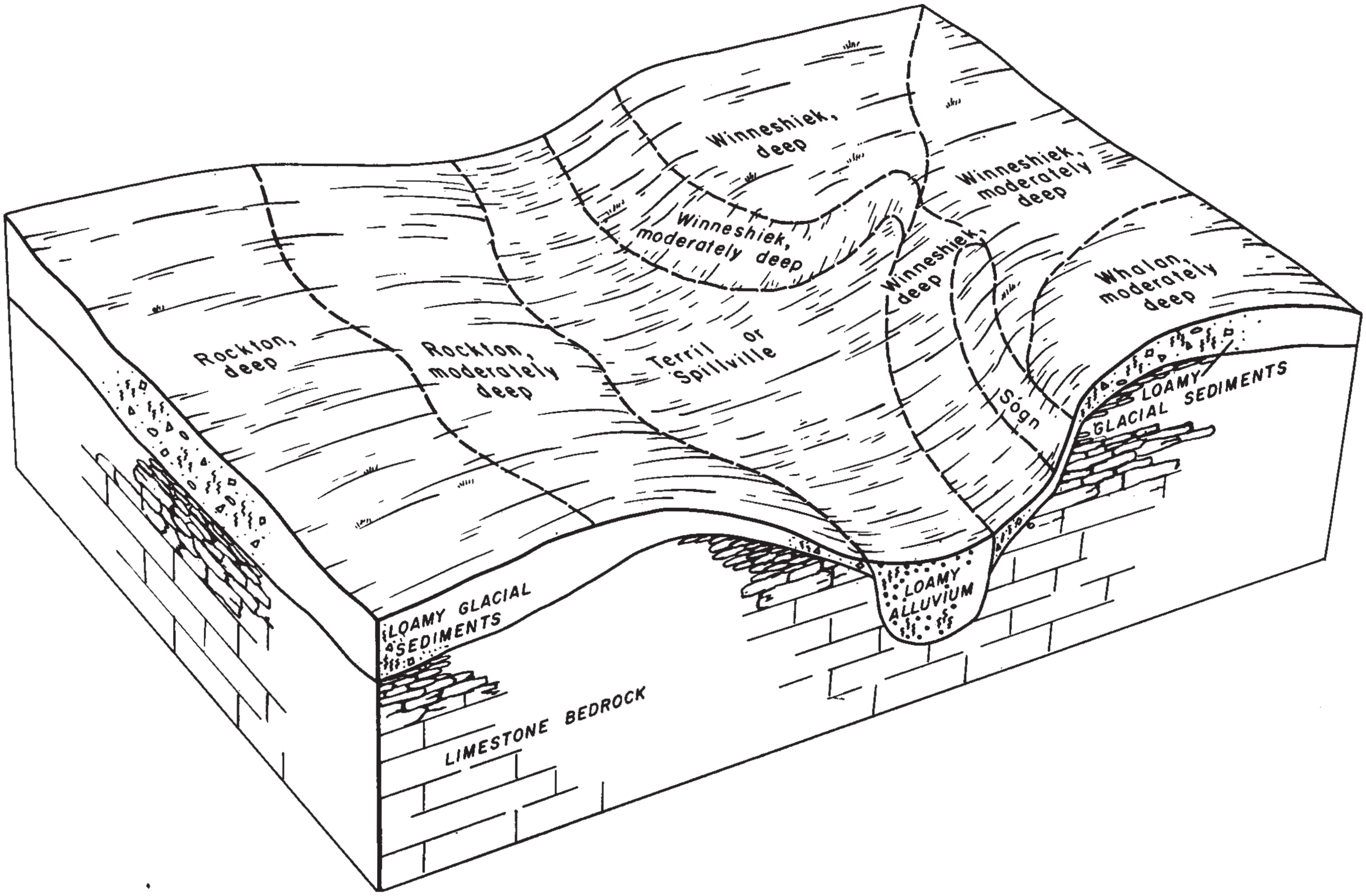


Figure 10.—**Relationship of soils and underlying materials in association 6.**

The Wapsie soils are nearly level to gently sloping and are well drained. They are mostly in broad areas on stream benches and on the sides of ridges and escarpments. They have a relatively thin, loamy surface layer that is dark grayish brown and brown and a loamy subsoil that is brown and dark yellowish brown. Sand and some gravel are below a depth of 20 to 36 inches. The general position of Wapsie soils is somewhat higher than that of the associated Hayfield and Marshan soils.

The Marshan soils are poorly drained. They have a thick surface layer of black and very dark gray clay loam and a subsoil that is mottled, grayish, and loamy. Sand and gravel commonly are at a depth of 30 to 40 inches.

The minor soils in this association include Colo soils, loamy substratum. These soils are poorly drained and make up about 4 percent of the survey area. They formed in deep, black, alluvial deposits of silty clay loam on bottoms. A large acreage of these soils is mapped in complexes with Spillville soils. Other important soils in this association are soils of the Lawler and Hayfield series. These soils make up a little more than 20 percent of the area. They are at slightly higher elevations than Marshan soils. Lawler soils are somewhat poorly drained. Their surface layer is thick, dark loam, and their subsoil is loamy. Sand and gravel are at a depth below 24 to 40 inches. Hayfield soils also are somewhat poorly drained. They have a relatively thin, dark surface layer and a loamy subsoil. Sand and gravel are at a depth below 24 to 40 inches. Other minor soils in this association are Dickinson, Waukee, and Sattre soils on benches; Ankeny, Turlin, acid variant, and Spillville soils on first bottoms; and the Colo-Alluvial land complex on first bottoms. These soils make up about 23 percent of the area.

Most of the soils in this association are on benches. They are used for cultivated crops and are well suited to this use. The soils on bottoms are mainly in permanent pasture or timber, primarily because of the hazard of flooding and the meandering stream channels. These soils are well suited to crops if cultivated, but they may need some protection from flooding. Some areas of these soils need tile drainage.

The management needs in this association are variable. Some places need flood control and drainage improvement, and others need erosion control. The soils in some areas are droughty. All of the soils need general improvement of fertility.

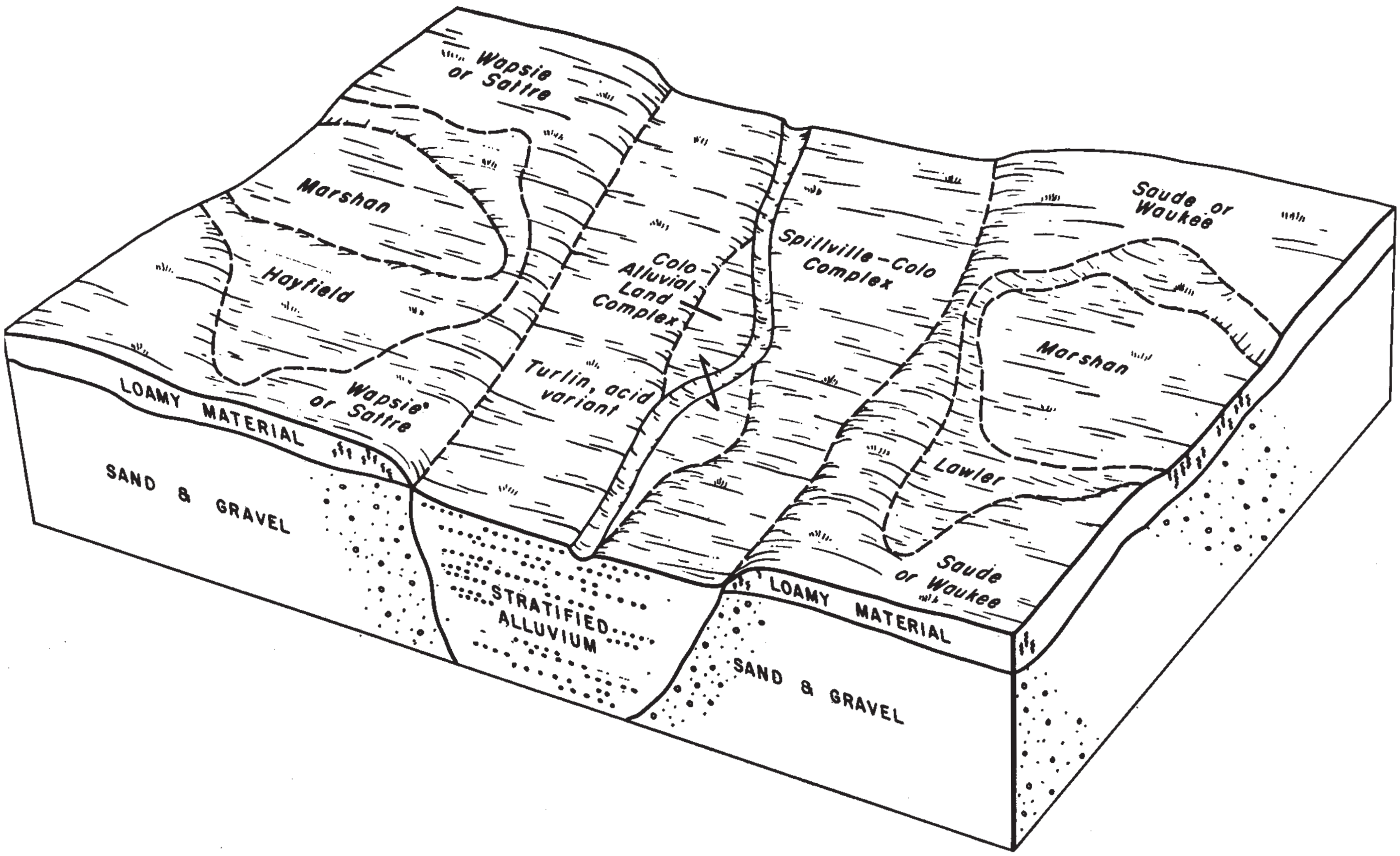


Figure 11.—**Relationship of soils and underlying materials in association 7.**

Descriptions of the Soils

This section describes the soil series, which are groups of similar soils, and the mapping units of Howard County. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure in this section is first to describe the soil series and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. Unless otherwise stated, the description of all mapping units in this section is for a moist soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Alluvial land and Marsh are miscellaneous land types and do not belong to a soil series; nevertheless, they are listed in alphabetic order along with the series.

For each series, there is a description of the soil profile, the sequence of layers beginning at the surface and continuing downward to the depth beyond which roots of most plants do not penetrate. There is a brief description of a typical soil profile for the layman and a much more detailed description of the same profile that scientists, engineers, and others can use in making highly technical interpretations.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit and the woodland suitability group in which the mapping unit has been placed. The pages on which each capability unit and woodland suitability group are described can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Alluvial Land

Alluvial land consists of recently deposited, highly stratified soils that have not been in place long enough for the development of a soil profile. This land type is frequently flooded, and each flood adds new sediment. The sediment varies in texture but is mainly loam, sandy loam, and silt loam.

Much of Alluvial land is channeled, and it is characterized by low natural levees, small ponds, sloughs, and small oxbows. Natural drainage ranges from poor in the channels to excessive on the natural levees. Because of the hazard of flooding and the oxbows and sloughs, this land type is poorly suited to crops. Much of it remains in permanent pasture. In Howard County, Alluvial land is mapped only in complexes with Colo soils.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent	Soil	Acres	Percent
Ankeny sandy loam, 0 to 2 percent slopes	429	0.1	Port Byron silt loam, 2 to 5 percent slopes	635	0.2
Backbone fine sandy loam, 2 to 5 percent slopes	278	.1	Protivin loam, 1 to 4 percent slopes	9,737	3.2
Backbone fine sandy loam, 5 to 9 percent slopes	274	.1	Racine loam, 0 to 2 percent slopes	580	.2
Bassett loam, 0 to 2 percent slopes	232	.1	Racine loam, 2 to 5 percent slopes	6,080	2.0
Bassett loam, 2 to 5 percent slopes	19,216	6.3	Racine loam, 5 to 9 percent slopes	619	.2
Bassett loam, 5 to 9 percent slopes	590	.2	Racine loam, 5 to 9 percent slopes, moderately eroded	229	.1
Bassett loam, 5 to 9 percent slopes, moderately eroded	361	.1	Radford silt loam	611	.2
Burkhardt sandy loam, 3 to 9 percent slopes	682	.2	Radford and Huntsville silt loams, 2 to 5 percent slopes	868	.3
Clyde silty clay loam	44,165	14.6	Readlyn loam, 0 to 2 percent slopes	1,272	.4
Cylde-Floyd complex, 1 to 4 percent slopes	7,008	2.3	Readlyn loam, 2 to 5 percent slopes	5,278	1.8
Coggon loam, 2 to 5 percent slopes	1,067	.4	Renova loam, 2 to 5 percent slopes	411	.1
Colo silty clay loam, loamy substratum	1,191	.4	Riceville loam, 1 to 4 percent slopes	4,582	1.5
Colo-Alluvial land complex	737	.2	Rockton loam, deep, 0 to 2 percent slopes	1,294	.4
Colo-Alluvial land complex, channeled	2,126	.7	Rockton loam, deep, 2 to 5 percent slopes	2,641	.9
Cresco loam, 2 to 5 percent slopes	9,714	3.2	Rockton loam, deep, 5 to 9 percent slopes	431	.1
Cresco loam, 5 to 9 percent slopes	579	.2	Rockton loam, moderately deep, 0 to 2 percent slopes	231	.1
Dickinson fine sandy loam, 0 to 2 percent slopes	322	.1	Rockton loam, moderately deep, 2 to 5 percent slopes	3,607	1.2
Dickinson fine sandy loam, 2 to 5 percent slopes	1,052	.4	Rockton loam, moderately deep, 5 to 9 percent slopes	1,304	.4
Dickinson-Ostrander complex, 2 to 5 percent slopes	380	.1	Rockton loam, moderately deep, 5 to 9 percent slopes, moderately eroded	228	.1
Dickinson-Racine complex, 2 to 5 percent slopes	538	.2	Sattre loam, 0 to 2 percent slopes	303	.1
Donnan loam, 0 to 2 percent slopes	219	.1	Saude sandy loam, 0 to 2 percent slopes	248	.1
Donnan loam, 2 to 5 percent slopes	660	.2	Saude sandy loam, 2 to 5 percent slopes	446	.1
Downs silt loam, 2 to 5 percent slopes	1,113	.4	Saude loam, 0 to 2 percent slopes	5,105	1.7
Downs silt loam, 5 to 9 percent slopes	587	.2	Saude loam, 2 to 5 percent slopes	3,046	1.1
Downs silt loam, 5 to 9 percent slopes, moderately eroded	2,968	1.0	Schley silt loam, 1 to 4 percent slopes	16,956	5.6
Downs silt loam, 9 to 14 percent slopes, moderately eroded	1,720	.6	Sogn loam, 2 to 5 percent slopes	365	.1
Downs silt loam, 14 to 20 percent slopes, moderately eroded	965	.3	Sogn loam, 5 to 14 percent slopes	2,430	.8
Fayette silt loam, 5 to 9 percent slopes	207	.1	Sogn loam, 14 to 40 percent slopes	1,498	.5
Fayette silt loam, 9 to 14 percent slopes	183	.1	Sparta loamy fine sand, 0 to 2 percent slopes	179	.1
Fayette silt loam, 14 to 20 percent slopes	220	.1	Sparta loamy fine sand, 2 to 5 percent slopes	379	.1
Fayette silt loam, 20 to 30 percent slopes	411	.1	Sparta loamy fine sand, 5 to 9 percent slopes	237	.1
Floyd loam, 1 to 4 percent slopes	38,478	12.8	Spillville loam	1,018	.3
Hayfield loam, deep	1,024	.3	Spillville-Colo complex	3,643	1.2
Hayfield loam, moderately deep	2,581	.8	Spillville-Colo complex, channeled	1,215	.4
Jacwin silty clay loam, 0 to 2 percent slopes	315	.1	Terril loam, 0 to 2 percent slopes	1,364	.5
Jamestown silty clay loam	2,694	.9	Terril loam, 2 to 5 percent slopes	331	.1
Kenyon loam, 2 to 5 percent slopes	18,769	6.3	Tripoli silty clay loam	752	.2
Kenyon loam, 5 to 9 percent slopes	590	.2	Turlin silt loam, acid variant	888	.3
Kenyon loam, 5 to 9 percent slopes, moderately eroded	371	.1	Wapsie loam, 0 to 2 percent slopes	4,506	1.5
Lamont fine sandy loam, 0 to 2 percent slopes	192	.1	Wapsie loam, 2 to 5 percent slopes	2,170	.7
Lamont fine sandy loam, 2 to 5 percent slopes	348	.1	Wapsie loam, 5 to 9 percent slopes	311	.1
Lamont fine sandy loam, 5 to 9 percent slopes	178	.1	Waukee loam, 0 to 2 percent slopes	1,004	.3
Lawler loam, deep	2,233	.7	Waukee loam, 2 to 5 percent slopes	282	.1
Lawler loam, moderately deep	1,680	.6	Whalan loam, moderately deep, 2 to 5 percent slopes	208	.1
Lilah sandy loam, 0 to 3 percent slopes	263	.1	Whalan loam, moderately deep, 5 to 9 percent slopes	169	.1
Lilah sandy loam, 3 to 9 percent slopes	911	.3	Winneshiek loam, deep, 0 to 2 percent slopes	814	.3
Lilah sandy loam, 9 to 14 percent slopes	140	.1	Winneshiek loam, deep, 2 to 5 percent slopes	1,725	.6
Lourdes loam, 2 to 5 percent slopes	5,335	1.8	Winneshiek loam, deep, 5 to 9 percent slopes	273	.1
Lourdes loam, 5 to 9 percent slopes	225	.1	Winneshiek loam, moderately deep, 0 to 2 percent slopes	258	.1
Marsh	180	.1	Winneshiek loam, moderately deep, 2 to 5 percent slopes	1,933	.6
Marshan clay loam, deep	4,526	1.2	Winneshiek loam, moderately deep, 5 to 9 percent slopes	943	.3
Marshan clay loam, depressional	428	.1	Winneshiek loam, moderately deep, 5 to 9 percent slopes, moderately eroded	185	.1
Muck, deep	263	.1	Winneshiek loam, moderately deep, 9 to 14 percent slopes	367	.1
Muck, moderately deep	523	.2	Winneshiek loam, shaly subsoil variant, 0 to 2 percent slopes	213	.1
Muck, shallow	443	.1			
Oran loam, 0 to 2 percent slopes	3,541	1.2			
Oran loam, 2 to 5 percent slopes	6,279	2.1			
Ostrander loam, 0 to 2 percent slopes	1,031	.4			
Ostrander loam, 2 to 5 percent slopes	10,003	3.3			
Ostrander loam, 5 to 9 percent slopes	475	.2			
Ostrander loam, 5 to 9 percent slopes, moderately eroded	312	.1			
Pinicon silt loam, 1 to 4 percent slopes	513	.2	Total	301,440	100.0

Ankeny Series

The Ankeny series consists of dark-colored, nearly level, somewhat excessively drained soils in bottoms. These soils are on the flood plains of rivers and narrow, intermittent streams and on low stream benches. They formed under grasses in coarse textured and moderately coarse textured alluvial sediment. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black, very dark brown, and very dark grayish-brown sandy loam about 44 inches thick. The subsoil is brown loamy sand about 7 inches thick. The substratum is sandy throughout and contains some gravel. It is pale brown in the upper part and grades to light gray in the lower part.

The available water capacity is moderate to low, and permeability is moderately rapid. Content of available phosphorus and potassium is very low. Reaction is neutral to medium acid. The seasonal water table is at a depth of more than 5 feet.

These soils are well suited to row crops.

Representative profile of Ankeny sandy loam, 0 to 2 percent slopes, 1,100 feet north and 360 feet west of southwest corner of sec. 1, T. 98 N., R. 12 W., in a cultivated field on a low, level bench adjacent to a stream:

Ap—0 to 8 inches, black (10YR 2/1) heavy sandy loam; moderate, very fine, granular structure; very friable; medium acid; clear, smooth boundary.

A12—8 to 23 inches, black (10YR 2/1) heavy sandy loam; weak, very fine, granular structure; very friable; medium acid; gradual, smooth boundary.

A13—23 to 37 inches, very dark brown (10YR 2/2) sandy loam; weak, medium, subangular blocky structure parting to weak, very fine, granular; very friable; medium acid; gradual, smooth boundary.

A3—37 to 44 inches, very dark grayish-brown (10YR 3/2) sandy loam; very weak, fine, subangular blocky structure; very friable; slightly acid; gradual, smooth boundary.

B—44 to 51 inches, brown (10YR 4/3) loamy sand that has dark grayish-brown (10YR 4/2) ped exteriors; weak, very fine, subangular blocky structure; very friable; slightly acid; clear, smooth boundary.

C1—51 to 57 inches, pale-brown (10YR 6/3) sand; single grain; loose; few very small pebbles; slightly acid; clear, smooth boundary.

C2—57 to 72 inches, light-gray (10YR 7/2) fine sand; single grain; loose; slightly acid.

The A horizon ranges from 36 to 45 inches in thickness. Value is 2 or 3, and chroma is 1 to 3. The B3 horizon ranges from sandy loam to loamy sand that has thin lenses of fine sand. Reaction ranges from neutral to medium acid in the most acid part of the profile.

Ankeny soils that are medium acid are outside the defined range for the series, but this does not alter the usefulness or behavior of the soils.

Ankeny soils formed in material similar to the parent materials of the Dickinson and Sparta soils. They have a dark-colored A horizon that is thicker than that of the Dickinson and Sparta soils. They also have less sand in the A horizon than the Sparta soils.

Ankeny sandy loam, 0 to 2 percent slopes (136A).—This soil is on bottom land and low stream benches. In most places it is at a somewhat higher elevation than the associated soils.

Included in mapping are a few areas of coarser textured soils that are somewhat more droughty than is typical for this Ankeny soil. In the northeastern part of the county, this soil has a higher content of lime than is typical, and it does not require liming.

This soil is well suited to row crops. It is somewhat droughty during extended dry periods. Some areas are subject to flooding, but flooding generally is of short duration. The organic-matter content of this soil is moderate. (Capability unit IIs–2; woodland suitability group 9)

Backbone Series

The Backbone series consists of moderately dark colored, somewhat excessively drained soils on uplands. These soils are gently sloping on ridges and moderately sloping on the sides of ridges. Most areas are within 2 miles of the Cresco city limits. The soils formed in 20 to 40 inches of a loamy material underlain by a thin layer of limestone residuum over limestone bedrock. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam 8 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is 23 inches thick. It is brown sandy loam in the upper part and dark yellowish-brown sandy clay loam in the lower part. At about 3½ feet is hard, shattered limestone that contains 10 to 15 percent friable fine sandy loam that is mixed with dominantly rectangular limestone fragments. Below this is hard, level-bedded limestone.

Available water capacity is low. Permeability is moderately rapid in the upper part and rapid in the limestone bedrock. Backbone soils are very low in content of available phosphorous and potassium and in organic-matter content. They range from slightly acid to strongly acid in the surface layer and from slightly acid to mildly alkaline in the lower part of the subsoil.

Backbone soils are used for row crops in rotation with legume meadow. Crop production is quite variable, and it depends on the amount and timeliness of rainfall.

Representative profile of Backbone fine sandy loam, 2 to 5 percent slopes, 800 feet west and 1,200 feet south of northeast corner of sec. 1, T. 98 N., R. 11 W., in a cultivated field on a slightly convex, south-facing slope:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; moderate, very fine, granular structure; very friable; slightly acid; clear, smooth boundary.

A2—8 to 12 inches, brown (10YR 4/3) and dark grayish-brown (10YR 4/2) light fine sandy loam, brown (10YR 5/3) and very pale brown (10YR 7/3) when dry; weak, medium, platy structure parting to very weak, fine, subangular blocky; very friable; few brown (10YR 5/3) and very pale brown (10YR 7/3) silt and sand coatings when dry; slightly acid; clear, wavy boundary.

B1—12 to 17 inches, brown (10YR 4/3) light sandy loam, pale brown (10YR 6/3) when dry; weak, medium, subangular blocky structure; very friable; few, very thin, patchy, dark yellowish-brown (10YR 3/4) clay films on ped faces; few very pale brown (10YR 7/3) silt and sand coatings when dry; slightly acid; clear, wavy boundary.

B21t—17 to 22 inches, dark yellowish-brown (10YR 4/4) sandy loam; dark yellowish-brown (10YR 3/4) ped coatings that have patchy dark-brown (10YR 3/3) clay films; weak, fine, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

B22t—22 to 27 inches, dark yellowish-brown (10YR 4/4) light sandy clay loam; nearly continuous very dark

grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) clay films on ped faces; moderate, fine, subangular blocky structure; firm; neutral; abrupt, wavy boundary.

IIB23t—27 to 29 inches, dark-brown (10YR 3/3) and dark yellowish-brown (10YR 4/4) heavy sandy clay loam; continuous, thick, very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) clay films on ped faces; moderate, fine and very fine, angular blocky structure; very firm; neutral; abrupt, wavy boundary.

IIB24t—29 to 35 inches, 40 percent of horizon is dark yellowish-brown (10YR 4/4) medium sandy clay loam and 60 percent is very pale brown (10YR 8/3) hard limestone fragments 1/8 inch to 3 inches long; dark-brown (10YR 3/3) clay films on ped faces and in pores and root channels; weak, medium, subangular blocky structure; very firm; slightly effervescent; mildly alkaline; clear, smooth boundary.

R1—35 to 80 inches, hard shattered limestone bedrock that is 10 to 15 percent sandy loam material; in the upper 12 inches are a few fragments that have thin patches of clayey residuum; limestone fragments are dominantly rectangular and locked in place; their lower limit is estimated.

R2—80 inches, hard, level-bedded limestone.

In uncultivated areas, the A1 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color and from 6 to 10 inches in thickness. In cultivated areas, the A2 horizon is incorporated into the plow layer in places. The B horizon ranges from light sandy loam to light sandy clay loam in the upper part and light sandy clay loam to light clay loam in the lower part. The clayey lower fringe of the B horizon ranges from 1/2 inch to 6 inches in thickness within a horizontal distance of a few feet. The shattered, upper layer of limestone, 2 to 5 feet thick, is 10 to 20 percent a material ranging from sandy loam to loamy sandy. In places it also has small bits of clayey material on the slabs and in the crevices in the uppermost few inches. As the soil slope increases, the thickness of the shattered limestone generally decreases. Reaction ranges from neutral to strongly acid in the most acid horizon.

Backbone soils formed in material similar to the parent material of the Dickinson, Lamont, and Sparta soils. They contain less sand in the B horizon than the Sparta soils and have a dark-colored A horizon that is thicker than that of Lamont soils. They have a lighter colored A horizon than the Sparta and Dickinson soils. In contrast to the Dickinson, Lamont, and Sparta soils, Backbone soils have a solum that terminates on limestone bedrock.

Backbone fine sandy loam, 2 to 5 percent slopes (109B).—This soil has the profile described as representative for the series. It generally is on or near the highest part of the landscape, but in places it is on the lower sides of ridges. The length of slopes is variable. Areas are about 2 to 6 acres in size. In uncultivated areas this soil has a very dark gray to very dark brown surface layer and a lighter colored subsurface layer. Limestone bedrock is at a depth of 24 to 40 inches in most places. Included in mapping in a few places are small gravelly spots.

This soil is moderately well suited to row crops if rainfall is normal and timely. It is subject to slight soil blowing and water erosion if cultivated. Terrace construction is difficult in some places because of the shallowness to limestone bedrock. (Capability unit IIIe-4; woodland suitability group 3)

Backbone fine sandy loam, 5 to 9 percent slopes (109C).—This soil has a profile similar to the one described as representative for the series, except that it is generally slightly shallower to bedrock. This soil is on uplands, generally on the short side slopes. Areas are about 2 to 4 acres in size. Limestone bedrock is at a depth of 20 to 34 inches in most places.

Included in mapping are a few small spots where limestone is exposed and a few small gravelly spots.

This soil is poorly suited to row crops. It is subject to soil blowing and water erosion if cultivated. (Capability unit IIIe-4; woodland suitability group 3)

Bassett Series

The Bassett series consists of moderately dark colored, nearly level to gently sloping, moderately well drained soils on uplands. These soils are on the crests and convex sides of ridges. They formed in 13 to 22 inches of loamy material and underlying glacial till. In most places a layer of pebbles and stones is at the contact line of the overburden and the glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam 8 inches thick. The subsurface layer is brown, friable loam 2 inches thick. The subsoil extends to a depth of 59 inches. It is brown and yellowish-brown heavy loam that is mottled with grayish brown and light gray below a depth of about 22 inches. The substratum is mottled yellowish-brown and light-gray loam.

Permeability is moderate in the upper part of these soils and moderately slow in the lower part. Water moves more rapidly through the loamy overburden than through the glacial till. This causes water to accumulate on the contact surface between the two parts and results in wet, seepy spots on these soils in some years. The available water capacity is high. Content of available phosphorus and potassium is very low. Reaction is generally acid, and the soils need lime unless they have been limed within the past 5 years.

Bassett soils are well suited to row crops if properly managed. Providing adequate drainage and controlling erosion are difficult because these two measures conflict in places. Sloping soils in long, uniform, upland areas are well suited to contour cultivation and terracing. These practices slow down the movement of surface water and allow more of it to soak into the soils, but the extra water entering the soils complicates drainage, especially in wet years.

Representative profile of Bassett loam, 2 to 5 percent slopes, 670 feet east and 500 feet north of southwest corner of sec. 24, T. 100 N., R. 14 W., in a cornfield on a convex slope of 2 1/2 percent that faces southwest:

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy loam, grayish brown (2.5Y 5/2) when dry; weak, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A2—8 to 10 inches, brown (10YR 4/3) heavy loam that has nearly continuous dark-brown (10YR 3/3) and very dark grayish-brown (10YR 3/2) ped coatings, pale-brown (10YR 6/3) and grayish-brown (10YR 5/2) silt and sand coatings when dry; very weak, medium, platy structure; friable; strongly acid; clear, wavy boundary.

B1—10 to 14 inches, brown (10YR 4/3) heavy loam that has discontinuous dark-brown (10YR 3/3) ped coatings and pale-brown (10YR 6/3) silt and sand coatings when dry; weak, fine, subangular blocky structure; friable; band of pebbles 1/4 inch to 2 inches in diameter in lower fringe; very strongly acid; clear, smooth boundary.

IIB21—14 to 22 inches, yellowish-brown (10YR 5/6) heavy loam that has brown (10YR 5/3) and yellowish-brown (10YR 5/4) prism and ped coatings; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; very few, fine, soft, strong-brown (7.5YR 5/6) oxides; a few small pebbles; very strongly acid; gradual, smooth boundary.

IIB22t—22 to 30 inches, mottled yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) heavy loam that has grayish-brown (2.5Y 5/2) and pale-brown (10YR 6/3) prism and ped coatings; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; firm; a few dark-gray (10YR 4/1) clay films on prism faces; few, fine, firm, dark reddish-brown (5YR 2/2) oxides and few, fine, soft, yellowish-red (5YR 4/6) oxides; a few small pebbles; strongly acid; gradual, smooth boundary.

IIB31t—30 to 43 inches, mottled yellowish-brown (10YR 5/8) and grayish-brown (2.5Y 5/2) heavy loam; nearly continuous grayish-brown (2.5Y 5/2) prism coatings that have common dark-gray (10YR 4/1) clay films and streaks; few grayish-brown (2.5Y 5/2) ped coatings that have very few dark-gray (10YR 4/1) clay films and streaks; moderate, coarse, prismatic structure parting to weak, medium, subangular blocky; firm; dark-gray (10YR 4/1) clay films are common in pores and root channels; few, fine, firm, dark reddish-brown (5YR 2/2) oxides and few, fine, soft, yellowish-red (5YR 5/8) oxides; few small pebbles; strongly acid; gradual, smooth boundary.

IIB32—43 to 59 inches, mottled yellowish-brown (10YR 5/8) and light-gray (5Y 6/1) heavy loam; very weak, coarse, prismatic structure parting to very weak, coarse, subangular blocky; firm; few dark-gray (10YR 4/1) clay films in root channels in upper part of horizon; few, fine, firm, dark reddish-brown (5YR 2/2) oxides and few, fine, soft, yellowish-red (5YR 5/8) oxides; slightly acid; clear, wavy boundary.

IIC—59 to 67 inches, mottled yellowish-brown (10YR 5/8) and light-gray (5Y 6/1) heavy loam; massive; firm; neutral.

In uncultivated areas the A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) and is 5 to 9 inches thick. The texture is generally loam, but it ranges to silt loam that contains enough sand to have a gritty feel. The A2 horizon is generallly loam but ranges to silt loam. In the A2 horizon, color ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3). In cultivated areas the A2 horizon is incorporated into the plow layer in places.

The loamy overburden ranges from 13 to 22 inches in thickness and contains more silt and less sand than the underlying till. The IIB horizon ranges from loam to clay loam or sandy clay loam. It is 20 to 29 percent clay, 35 to 55 percent sand, and 2 to 6 percent gravel. Depth to mottles that are 2 in chroma is 20 to 30 inches. The most acid part of the IIB2 horizon is medium acid to very strongly acid. Depth to calcareous till ranges from 50 to 90 inches.

Bassett soils formed in material similar to the parent materials of Coggon, Kenyon, Lourdes, and Racine soils. Their dark-colored A horizon is thicker than that of the Coggon soils, but not so thick as the A horizon of Kenyon soils. Compared with Racine soils, the IIB2 horizon in Bassett soils is not so friable, and it contains grayish mottles that are lacking in Racine soils. The IIB horizon is less clayey in Bassett soils than in Lourdes soils, and is more friable.

Bassett loam, 0 to 2 percent slopes (171A).—This soil is mostly on the crests of the higher ridges on uplands. Areas are about 2 to 4 acres in size.

This soil is well suited to row crops. It has few limitations. In a wet season, fieldwork may be slightly delayed. The organic-matter content of this soil is moderate. (Capability unit I–2; woodland suitability group 6)

Bassett loam, 2 to 5 percent slopes (171B).—This soil has the profile described as representative for the series. It is on long, convex ridges and the sides of ridges. In most places, it is upslope from Schley and Floyd soils. Most of the areas are about 4 to 20 acres in size, but they range from 2 to 80 acres.

Included in mapping are a few sandy spots that are more droughty than is typical for this soil. In some places there are small eroded spots where the surface is brown or dark brown.

This soil is well suited to row crops. If cultivated, it is subject to a slight hazard of erosion. A combination of terracing and tile drainage is needed in places to control erosion and provide adequate drainage. In a wet season, fieldwork can be slightly delayed. The organic-matter content of this soil is moderate. (Capability unit IIe–1; woodland suitability group 6)

Bassett loam, 5 to 9 percent slopes (171C).—This soil has fairly short, convex slopes and is below the more gently sloping Bassett soils. Most areas are in the vicinity of larger streams and are about 2 to 15 acres in size. In some places there are small eroded spots where the surface is brown and dark brown, and a few sandy spots are in some areas. Water moves through the loamy overburden faster than through the glacial till, and for this reason it accumulates at the contact surface and then moves downhill along this contact line. Because this soil generally is in lower positions that gently sloping Bassett soils, seep spots are likely to occur in spring, especially in wet years.

This soil is well suited to row crops if properly managed. It is subject to moderate to severe erosion if it is cultivated. In wet seasons, fieldwork may be delayed slightly. A combination of tile drainage and terracing is needed in places to provide adequate drainage and to control erosion. The organic-matter content of this soil is moderate (Capability unit IIIe–1; woodland suitability group 6)

Basset loam, 5 to 9 percent slopes, moderately eroded (171C2).—This soil has a profile similar to the one described as representative for the series, except that some of the subsoil is mixed in the very dark grayish-brown and brown plow layer. Most areas are in the vicinity of larger streams and are about 2 to 8 acres in size. Glacial till is 10 to 14 inches below the surface, and in a few severely eroded spots, it is exposed. In comparison with Bassett soils that are not eroded, this soil is lower in content of organic matter in the surface layer, is lower in content of potassium, and is shallower to firm glacial till of low fertility. A few sandy spots are in some areas, and these are shown on the soil map by a symbol.

This soil has rather short, convex slopes and is below the gently sloping Bassett soils. Water tends to accumulate at the contact surface between the loamy overburden and the glacial till and then move downhill along the contact line and come to the surface at lower elevations. Because this soil is generally at lower elevations than other Bassett soils, it is likely to have wet, seepy spots in spring, especially in wet years.

This soil is suited to row crops if properly managed. It is subject to severe erosion if it is cultivated. In wet seasons, fieldwork is slightly delayed. A combination of terracing and tile drainage is needed in places to provide

501-192—74——2

adequate erosion control and drainage. The organic-matter content of this soil is moderately low. (Capability unit IIIe–1; woodland suitability group 6)

Burkhardt Series

The Burkhardt series consists of dark-colored, excessively drained, gently sloping to moderately sloping soils. These soils formed in 10 to 20 inches of sandy loam containing a few pebbles and in underlying gravelly loamy sand or sand on stream benches and uplands. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and dark-brown sandy loam that is 12 inches thick and contains a few pebbles. The subsoil, 4 inches thick, is dark yellowish-brown, very friable sandy loam that contains some pebbles. The substratum is dark yellowish-brown and yellowish-brown gravelly loamy sand and sand.

Burkhardt soils have very low available water capacity and very rapid permeability. They are very low in content of available phosphorus and potassium and moderately low in content of organic matter. The Burkhardt soils are acid and need lime unless they have been limed within the past 4 years. They absorb water at a high rate but erode readily if in row crops.

Representative profile of Burkhardt sandy loam, 3 to 9 percent slopes, 1,220 feet west and 170 feet south of northeast corner of sec. 35, T. 98 N., R. 14 W., in a cultivated field on a convex, west-facing slope of 4 percent:

Ap—0 to 9 inches, very dark brown (10YR 2/2) heavy sandy loam; clods parting to weak, very fine, granular structure; very friable; few very small pebbles; strongly acid; clear, smooth boundary.

A3—9 to 12 inches, dark-brown (10YR 3/3) heavy sandy loam; weak, medium, subangular blocky structure; very friable; few very small pebbles; very strongly acid; gradual, smooth boundary.

B—12 to 16 inches, dark yellowish-brown (10YR 3/4) sandy loam that has dark-brown (10YR 3/3) ped coatings; weak, medium, subangular blocky structure; very friable; few very small pebbles; strongly acid; clear, smooth boundary.

IIC1—16 to 28 inches, dark yellowish-brown (10YR 4/4) gravelly loamy sand; single grain; loose; about 12 percent is fine and medium gravel; medium acid; gradual, smooth boundary.

IIC2—28 to 37 inches, yellowish-brown (10YR 5/6) gravelly coarse sand; about 14 percent is fine and medium gravel; single grain; loose; medium acid; clear, smooth boundary.

IIC3—37 to 44 inches, yellowish-brown (10YR 5/6) sandy gravel; about 40 percent is gravel; single grain; loose; medium acid; clear, smooth boundary.

IIC4—44 to 72 inches, yellowish-brown (10YR 5/6) coarse sand; single grain; loose; few small pebbles; medium acid.

The Ap, A1, and A3 horizons are generally sandy loam but range to light loam and gravelly sandy loam. Depth to contrasting textures of gravelly loamy sand and sand is 10 to 20 inches. The content of gravel is quite variable. In most places the greatest concentrations of gravel-size material are at a depth of less than 50 inches. Reaction of the B horizon is medium acid to strongly acid in the most acid part of the profile. Calcareous material is at a depth of more than 90 inches.

Burkhardt soils formed in material similar to the parent material of Lilah soils. They have a thicker, darker colored A1 horizon than the Lilah soils.

Burkhardt sandy loam, 3 to 9 percent slopes (285C).—This soil is mostly on uplands. Some areas of it are on narrow bench escarpments. Most areas are 2 to 4 acres in size. In a few places the surface layer consists of light loam. Gravelly material is on the surface in spots. In a few areas the soils have a dark sandy loam surface layer that is 20 to 30 inches thick.

This soil is poorly suited to row crops. It is excessively drained and droughty and is subject to slight soil blowing and water erosion if cultivated. (Capability unit IVs–2; woodland suitability group 1)

Clyde Series

The Clyde series consists of dark-colored, poorly drained, nearly level to gently sloping soils in drainageways and depressional areas on uplands. These soils formed in 20 to 40 inches of moderately fine textured material and the underlying medium-textured, friable glacial till or valley fill that is stratified. In some places a layer of pebbles and stones is between the glacial till and the overlying material. Native vegetation was grasses and sedges.

In a representative profile the surface layer is black and very dark gray silty clay loam 24 inches thick. The subsoil extends to a depth of about 50 inches. It is mottled with olive gray, olive brown, and yellowish brown, and its texture ranges from friable silty clay loam to loam that has strata of loamy sand. The substratum is mottled olive-brown, yellowish-brown, and gray loam that contains some stones and pebbles.

Clyde soils have a high available water capacity. They are moderately permeable, but water moves through the layers at variable rates because of differences in texture. These soils are very low in content of phosphorus and potassium and high or very high in content of organic matter. Reaction is neutral in most places. Clyde soils are wet, at least partly because of hillside seepage from the Floyd and Kenyon soils that commonly occur upslope.

Representative profile of Clyde silty clay loam 1,210 feet north and 53 feet east of southwest corner of sec. 3, T. 99 N., R. 14 N., in a pasture on a concave, east-facing slope of 1 percent:

A1—0 to 19 inches, black (N 2/0) silty clay loam; weak, fine, granular structure; friable; few, fine, distinct, dark-brown (7.5YR 3/2) mottles near the roots; few small pebbles; neutral; gradual, smooth boundary.

A3—19 to 24 inches, very dark gray (N 3/0) light silty clay loam; common, distinct, olive-gray (5Y 5/2) and light olive-brown (2.5Y 5/4) mottles; very dark gray (2.5Y 3/1) ped coatings in upper part grading to dark gray (5Y 4/1) with increasing depth; moderate, very fine, subangular blocky structure; friable; few, fine, soft, yellowish-brown (10YR 5/8) oxides; neutral; gradual, smooth boundary.

B21g—24 to 32 inches, mottled olive-gray (5Y 5/2) and olive-brown (2.5Y 4/4) light silty clay loam that has nearly continuous olive-gray (5Y 5/2) ped coatings; moderate, fine and very fine, subangular blocky structure; friable; few, fine, strong-brown (7.5YR 5/6) and dark reddish-brown (5YR 2/2) oxides; band of pebbles in lower part of horizon; neutral; clear, smooth boundary.

IIB22g—32 to 41 inches, mottled olive-brown (2.5Y 4/4) and grayish-brown (2.5Y 5/2) heavy loamy sand; common, fine, prominent, strong-brown (7.5YR 5/6) mot-

tles; very weak, medium, subangular blocky structure; very friable; few small pebbles; neutral; clear, smooth boundary.

IIIB3—41 to 50 inches, mottled yellowish-brown (10YR 5/6) and olive-gray (5Y 5/2) heavy loam; weak, medium, prismatic structure parting to very weak, coarse, subangular blocky; firm, few, gray (5Y 5/1) prism and ped coatings; few small pebbles; neutral; clear, smooth boundary.

IIIC—50 to 66 inches, mottled yellowish-brown (10YR 5/6), olive-brown (2.5Y 4/4), and gray (N 5/0) heavy loam; massive; firm; few yellowish-red (5YR 5/8) oxides; strongly effervescent, mildly alkaline.

The A horizon generally is black (10YR 2/1 or N 2/0) but ranges to very dark gray (10YR 3/1) and is about 16 to 24 inches thick. Texture ranges from silty clay loam or clay loam to silt loam or loam. In many places the material contains enough sand to have a gritty feel. The B horizon ranges from light clay or gritty silty clay loam to loam that has thin strata of sandy loam or loamy sand. Depth to unstratified, firm loam till ranges from 36 to 80 inches. Clyde soils generally are neutral throughout, but in places they are slightly acid in the most acid horizon. Depth to carbonates ranges from 40 to 70 inches.

Clyde soils formed in material similar to the parent material of Floyd and Marshan soils. They are more poorly drained and have colors of lower chroma in the upper part of the B horizon than Floyd soils. Clyde soils have a loam-textured IIIC horizon, but Marshan soils have a IIIC horizon of sand and gravel.

Clyde silty clay loam (0 to 3 percent slopes) (84).—This soil is in drainageways and the lower concave areas on uplands. The drainageways are almost level across the bottom, and most of them have so little slope that water flows through them very slowly. Areas range from 3 acres to several hundred acres in size. Some areas extend across 2 or 3 farms. Where this soil is associated with the very firm till soils, the material at a depth below 40 to 70 inches is clay loam in places. A few stones or boulders are on the surface in some places.

Included in mapping are a few, small, seepy muck areas and these are generally shown on the soil map by a spot symbol. In these areas the subsoil is bluish gray.

If properly drained this soil is well suited to row crops. Undrained areas are generally in pasture. Tilth generally is good, but the soil puddles if worked when wet. The major limitation is wetness; therefore, artificial drainage is needed. Because the wetness is due at least in part to sidehill seepage, a drainage system that intercepts the water that moves laterally through the soil is most effective. Large granite boulders are common in many undrained areas and need to be removed before the soil can be cropped. (Capability unit IIw-1; woodland suitability group 10)

Clyde-Floyd complex, 1 to 4 percent slopes (391B).—The soils of this complex are on uplands. They generally occupy small drainageways that are associated with the better drained and more sloping glacial till soils. In most places, the Clyde soils are in the center of the drainageway and a band of the Floyd soils border or finger into the drainageways. Areas range from about 3 to 8 acres in size and commonly are quite narrow and long. They generally extend across more than one farm. Generally, areas in this complex consist of about 60 percent Clyde soils and 40 percent Floyd soils.

These soils are well suited to row crops when properly drained. Most of the acreage is in drainageways where water concentrates, and generally the drainageways are grassed. Except in areas where a combination of tiling and terracing is used, waterways are not needed and use is determined by the use of the adjoining soils.

The major limitation is wetness, and tile drains should be installed. Large granite boulders are common in many areas. They need to be removed before these soils can be cropped. (Capability unit IIw-1; woodland suitability group 10)

Coggon Series

The Coggon series consists of light-colored, gently sloping, moderately well drained soils on uplands. These soils are on the long crests and convex sides of ridges. They formed in 13 to 22 inches of loamy material and underlying glacial till. In most places a layer of pebbles and stones is at the contact line of the overburden and the glacial till. The native vegetation was trees.

In a representative profile the surface layer is black loam about 3 inches thick. The subsurface layer is dark grayish-brown and brown loam 7 inches thick. The subsoil extends to a depth of 60 inches and is brown to yellowish-brown heavy loam that is mottled with grayish brown below a depth of about 28 inches. The substratum is yellowish-brown and strong-brown firm loam that is calcareous.

Permeability is moderate in the upper part of these soils and moderately slow in the lower part. Water moves more rapidly through the loamy overburden than through the glacial till. This causes water to accumulate at the till contact line, and it causes seepy spots in some years. Available water capacity is high. Available phosphorus is low, and available potassium is very low. Reaction is acid. The soil needs lime unless it has been limed within the past 5 years.

Providing adequate drainage and controlling erosion are difficult because the two measures conflict in some areas. The sloping soils in long, uniform areas on uplands are well suited to contour cultivation and terracing, which slows the movement of surface water and lets more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of tile drainage and terracing helps to overcome this difficulty.

Representative profile of Coggon loam, 2 to 5 percent slopes, 125 feet east and 20 feet south of the northwest corner of SW¼ sec. 7, T. 97 N., R. 11 W., in an open stand of timber on a slightly convex, east-facing slope of 2 percent:

O2—1 inch to 0, organic matter.

A1—0 to 3 inches, black (10YR 2/1) light loam, very dark gray (10YR 3/1) when kneaded; moderate, very fine, granular structure; friable; strongly acid; clear, smooth boundary.

A21—3 to 6 inches, dark grayish-brown (10YR 4/2) light loam that in a few places has an admixture of very dark gray (10YR 3/1) material; light gray (10YR 7/2) when dry; moderate, thin, platy structure; friable; very strongly acid; clear, smooth boundary.

A22—6 to 10 inches, brown (10YR 4/3) light loam that has very dark grayish-brown (10YR 3/2) and dark grayish-brown (10YR 4/2) ped coatings; weak, medium, platy structure; friable; light-gray (10YR 7/2) silt and sand coatings when dry; very strongly acid; clear, wavy boundary.

B1t—10 to 16 inches, brown (10YR 4/3) medium loam; dark grayish-brown (10YR 4/2) ped coatings; moderate, fine, subangular blocky structure; friable; nearly continuous light-gray (10YR 7/2) silt and sand coatings when dry; few, thin, discontinuous, very dark grayish-brown (10YR 3/1) clay films; band of pebbles ½ to 3 inches in diameter; strongly acid; clear, smooth boundary.

IIB21t—16 to 28 inches, dark yellowish-brown (10YR 4/4) heavy loam that has brown (10YR 4/3) prism and brown (10YR 5/3) ped coatings; common, fine, faint, yellowish-brown (10YR 5/8) mottles; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; firm; light-gray (10YR 7/2) silt and sand coatings when dry; thin, discontinuous, dark grayish-brown (10YR 4/2) clay films on prism and ped faces; most pores lined with very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) clay films; few, fine, firm, black (10YR 2/1) oxides; few small pebbles; strongly acid; clear, wavy boundary.

IIB22t—28 to 42 inches, yellowish-brown (10YR 5/6) heavy loam that has brown (10YR 5/3) prism and ped coatings; common, fine, faint, strong-brown (7.5YR 5/8) mottles and very few, fine, distinct, grayish-brown (10YR 5/2) mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; very pale brown (10YR 7/3) silt and sand coatings; when dry; few, thin, discontinuous, very dark grayish-brown (10YR 3/2) clay films on prism faces and in pores and root channels; strongly acid; gradual, smooth boundary.

IIB3t—42 to 60 inches, strong-brown (7.5YR 5/8) and yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; firm; thick, discontinuous, dark grayish-brown (10YR 4/2) clay films on prism faces and very dark gray (N 3/0) clay films in some pores and root channels; few small pebbles; medium acid; clear, wavy boundary.

IIC—60 to 75 inches, strong-brown (7.5YR 5/8) and yellowish-brown (10YR 5/6) heavy loam; few, fine, distinct, grayish-brown (10YR 5/2) mottles; massive; firm; few, soft, white (10YR 8/1) lime concretions; very few pores lined with very dark gray (N 3/0) clay films; few pebbles; strongly effervescent; mildly alkaline.

In areas that are not cultivated, the A1 horizon ranges from 1 to 4 inches in thickness. The texture is loam to silt loam that contains enough sand to feel gritty. In cultivated areas the plow layer generally is dark grayish brown (10YR 4/2) or brown (10YR 4/3) and is 6 to 8 inches thick. The A2 horizon commonly is 4 to 10 inches thick, and in some cultivated areas it is wholly mixed into the plow layer. Depth to grayish-brown and gray mottles is between 20 and 34 inches. The B horizon generally is loam, but in places it is light clay loam or sandy clay loam. It ranges from medium acid to very strongly acid. Depth to carbonates ranges from 50 to 90 inches.

Coggon soils formed in material similar to the parent materials of Bassett and Renova soils. They have a dark-colored A horizon that is thinner than Bassett soils. The IIB2 horizon is more firm than in Renova soils and contains grayish mottles that are lacking in Renova soils.

Coggon loam, 2 to 5 percent slopes (302B).—This soil is on long, convex ridges and on sides of ridges. It is associated with Renova, Bassett, Pinicon, and Schley soils. Most areas are about 2 to 15 acres in size.

This soil is well suited to row crops. The hazard of erosion is slight if it is cultivated. The difference between the permeability of the loamy overburden and that of the underlying glacial till causes water to accumulate at a depth of about 1½ feet, where the two layers are in contact. This accumulation produces a temporary high water table, particularly early in spring. A combination of terracing and tile drainage is needed in places to control erosion and provide adequate drainage. The content of organic matter in this soil is low. (Capability unit IIe-1; woodland suitability group 6)

Colo Series

The Colo series consists of dark-colored, poorly drained, level to nearly level soils on flood plains of rivers and narrow intermittent streams throughout the county. These soils formed in moderately fine textured alluvial deposits. Native vegetation was prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black silty clay loam 31 inches thick. The subsoil extends to a depth of 47 inches. It is mottled, black, friable clay loam and black sandy loam. The substratum reaches to a depth of 72 inches or more. It is stratified, dark-gray, black, and very dark gray loamy sand in the upper part and loam that contains some gravel in the lower part.

Colo soils have high available water capacity and moderately slow permeability. They are low to medium in content of available phosphorus and low in content of available potassium.

Representative profile of Colo silty clay loam, loamy substratum, 700 feet north and 660 feet west of southeast corner of NE¼ sec. 35, T. 98 N., R. 14 W., in a pasture on level first bottom:

A11—0 to 15 inches, black (10YR 2/1) light silty clay loam; moderate, very fine, granular structure; friable; slightly acid; clear, smooth boundary.

A12—15 to 31 inches, black (N 2/0) light silty clay loam; weak, medium, subangular blocky structure parting to weak, very fine, granular; friable; neutral; gradual, smooth boundary.

B2g—31 to 38 inches, black (10YR 2/1) clay loam; common, fine, distinct, brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; friable; few, fine, firm, dark reddish-brown (2.5YR 3/4) oxides and coatings on some pebbles; few small pebbles; neutral; clear, smooth boundary.

B3—38 to 47 inches, black (N 2/0) heavy fine sandy loam; very weak, coarse, subangular blocky structure; friable; neutral; clear, smooth boundary.

IIC1g—47 to 58 inches, dark-gray (5Y 4/1) loamy medium sand that is mixed with a small amount of very dark gray (10YR 3/1) medium sandy loam; massive; loose; neutral; clear, smooth boundary.

IIC2—58 to 72 inches, stratified black (10YR 2/1) loam and very dark gray (10YR 3/1) gravelly fine sandy loam; massive; friable; neutral.

The solum is black (N 2/0) to very dark gray (10YR 3/1) to a depth of at least 40 inches. The A horizon is silty clay loam that contains enough sand to feel gritty in the upper 10 to 20 inches, but it ranges to clay loam or loam below that depth. The B horizon ranges from black (10YR 2/1) to light olive gray (5Y 6/2) in color and from loam or clay loam to sandy loam in texture. The C horizon is below a depth of about 50 inches. It is generally stratified loamy sand, sandy loam, or loam and some gravel. Reaction throughout the profile ranges from slightly acid to neutral, and the depth to carbonates is generally more than 60 inches.

Between depths of 10 and 40 inches in some places, the sand content is higher and the clay content is lower than in the range defined for the series, but this difference does not alter the usefulness or behavior of these soils.

Colo soils formed in material similar to the parent material of the Turlin, acid variant, and the Spillville soils, but they are more poorly drained than those soils. They also have a thicker A horizon than the Turlin soils, acid variant.

Colo silty clay loam, loamy substratum (0 to 2 percent slopes) (133).—This soil has the profile described as representative for the series. It is on flood plains throughout the county and is adjacent to Spillville and Turlin soils, acid variant, or to the Colo-Alluvial land complex in most places. Most areas are 3 to 50 acres in size.

Included in mapping are a few small areas of soils that have gray colors between depths of 30 and 40 inches. Also included are a few small spots of a soil that is coarser textured than this Colo soil.

If properly drained, this soil is well suited to row crops. Tilth generally is good, but the soil puddles if it is worked when wet. Wetness is the major limitation. It is caused by flooding and, in places, by a high water table. Excess moisture often delays plowing in spring. Consequently, it is better to plow this soil in fall, when moisture conditions are more favorable. Areas that are frequently flooded are generally used for pasture. The organic-matter content of this soil is high. (Capability unit IIw–4; woodland suitability group 10)

Colo-Alluvial land complex (715).—This complex occurs in areas along a few of the major streams and some of the minor streams and on a few of the lower benches. The topography generally is uniform, but in some places it consists of depressional areas or discontinuous stream channels. In most places the poorly drained Colo soils and the somewhat poorly drained Alluvial land, both of which are dark colored, make up 60 to 80 percent of this complex. Dark-colored, well-drained, sandy soils make up the remaining 20 to 40 percent.

The suitability of this complex for row crops is variable because of the difficulty of draining the wet areas and the great variations in management and fertility requirements. These soils are subject to some flooding, and levees are needed in places to reduce flooding of cropped areas. Many areas of these soils that are not drained and protected against flooding are in pasture. The organic-matter content of these soils ranges from high to low. (Capability unit IIIw–3; woodland suitability group 10)

Colo-Alluvial land complex, channeled (315).—This complex occurs along nearly all of the major streams and some of the minor streams and on a few of the lower terraces. This nearly level complex is subject to frequent flooding. The topography is channeled, and it consists of many low natural levees, small ponds, sloughs, and small oxbows. The channels are of various sizes. Water stands in some of the deeper depressions the year round. The poorly drained Colo soils and the somewhat poorly drained Alluvial land, channeled, both of which are dark colored, make up 50 to 70 percent of this complex.

Well-drained, dark-colored, sandy soils and recent deposits of sandy material make up the remaining 30 to 50 percent. The recent sandy deposits generally occur as sand bars adjacent to streams or former stream channels. They consist of fine, medium, and coarse sand and a few deposits of gravel and sandy loam.

Included in mapping are a few small areas of Marsh.

These soils are not suited to row crops, because of the many channels and the hazard of flooding. Many areas of these soils are covered with scattered trees. Some areas need to be cleared of the thick growth of young trees and underbrush to make them suitable for pasture. The few good stands of hardwood trees should be allowed to remain. The organic-matter content of these soils ranges from high to low. (Capability unit Vw–1; woodland suitability group 10)

Cresco Series

The Cresco series consists of dark-colored, moderately well drained, slowly permeable soils. These soils are gently sloping to moderately sloping and are on long, convex ridges and the sides of ridges on uplands. They formed in 13 to 22 inches of loamy material and the underlying very firm clay loam glacial till. In most places a layer of pebbles and stones is between the overburden and the glacial till. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown loam about 13 inches thick. The subsoil is 34 inches thick. It is brown, friable loam in the upper part and mottled strong-brown and gray, very firm clay loam in the lower part. The substratum, which begins at a depth of 47 inches and reaches to a depth of 60 inches or more, is strong-brown, very firm clay loam that has many gray mottles.

Cresco soils have high available water capacity. They are very low in content of available phosphorus and potassium. The content of organic matter is high. Reaction is acid, and the soils need lime unless they have been limed within the last 5 years. Water moves through the loamy overburden more rapidly than through the glacial till, and for this reason it accumulates at the contact surface of the two materials. This results in a seasonal perched water table and sidehill seepage in wet years. The uppermost 1 to 2 feet of these soils is moderately permeable, and below this the soils are slowly permeable.

Providing adequate drainage and at the same time controlling erosion are difficult because the two measures conflict to some extent. The long, uniform slopes on uplands are well suited to contour plowing and terracing. These practices slow the movement of surface water and allow more of it to soak into the soil. The extra water entering the soil complicates the problem of drainage, especially in wet years.

Representative profile of Cresco loam, 2 to 5 percent slopes, 940 feet north and 76 feet east of southwest corner of sec. 11, T. 99 N., R. 13 W., in a cultivated field on a convex, east-facing slope of 3 percent:

Ap—0 to 8 inches, black (10YR 2/1) heavy loam; clods parting to weak, fine, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

A3—8 to 13 inches, mixed black (10YR 2/1) and very dark grayish brown (10YR 3/2) heavy loam that has some brown (10YR 4/3) in the lower part; weak, medium, subangular blocky structure parting to moderate, fine, granular; friable; strongly acid; gradual, smooth boundary.

B1—13 to 17 inches, mixed brown (10YR 4/3) and very dark grayish-brown (10YR 3/2) heavy loam; weak, fine, subangular blocky structure; friable; strongly acid; gradual, smooth boundary.

IIB21—17 to 25 inches, brown (10YR 4/3) heavy loam; few, fine, faint, brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; band of pebbles in upper part of horizon; strongly acid; clear, smooth boundary.

IIB22t—25 to 40 inches, mottled strong-brown (7.5YR 5/8) and gray (5Y 5/1) medium clay loam that has continuous gray (5Y 5/1) ped coatings; moderate, me-

dium, prismatic structure parting to moderate, medium, subangular blocky; very firm; few dark gray (N 4/0) clay films in root channels and on a few peds; interior gray colors are concentrated around most pores and line them; few pebbles; strongly acid; gradual, smooth boundary.

IIB3—40 to 47 inches, mottled strong-brown (7.5YR 5/8) and gray (5Y 5/1) clay loam that has discontinuous gray (5Y 5/1) ped coatings; weak, medium, prismatic structure parting to weak, medium, subangular blocky; very firm; few pebbles; neutral; clear, wavy boundary.

IIC—47 to 60 inches, strong-brown (7.5YR 5/8) clay loam; many, prominent, gray (5Y 6/1) mottles; massive; very firm; few, small, firm, yellowish-red (5YR 4/6 and 5/8) oxides; few pebbles; strongly effervescent; mildly alkaline.

The A horizon in uneroded areas ranges from black (10YR 2/1) or very dark gray (10YR 3/1) to very dark brown (10YR 2/2) and is 10 to 14 inches thick. Texture is generally loam but ranges to silt loam, which contains enough sand to feel gritty, and light clay loam. Depth to very firm clay loam till ranges from 18 to 30 inches. The gray color of the ped faces decreases as depth increases. The average clay content of the B2 horizon ranges from 30 to 35 percent. Reaction ranges from medium acid to very strongly acid in the most acid horizon. Depth to carbonates ranges from 40 to 70 inches.

Cresco soils formed in material similar to the parent material of Lourdes and Kenyon soils. They have a dark-colored A horizon that is thicker than that of Lourdes soils. Cresco soils contain more clay and are firmer in the IIB horizon than Kenyon soils.

Cresco loam, 2 to 5 percent slopes (783B).—This soil has the profile described as representative for the series. It is on long, convex ridges and the sides of ridges. It is associated with Protivin and Lourdes soils and generally is above Protivin and Floyd soils. In most places areas range from 3 acres to about 60 acres in size.

This soil is well suited to row crops. If cultivated, it is subject to slight erosion. Permeability in the loamy overburden is more rapid than in the underlying glacial till, which is at a depth of about 1½ feet. For this reason water accumulates where the two layers are in contact and produces a temporary high water table, particularly early in spring. Because of the difficulty of controlling erosion and at the same time providing adequate drainage, a combination of terracing and tile drainage is needed. Careful placement and spacing of the drains are important because of the slowly permeable subsoil. (Capability unit IIe–2; woodland suitability group 7)

Cresco loam, 5 to 9 percent slopes (783C).—This soil is on rather short, convex sides of ridges below areas of gently sloping Cresco soils and above Floyd and Clyde soils. In most places areas are about 2 to 5 acres in size.

Included in mapping are eroded areas of soils that have a plow layer of mixed very dark grayish brown and dark brown. In these eroded areas the glacial till is 10 to 14 inches below the surface. The eroded areas are shown on the soil map by a symbol. Also included in a few places are small sandy spots.

This soil is moderately well suited to row crops. If cultivated, it is subject to moderate to severe erosion. Because this soil commonly is at lower elevations than other Cresco soils, water accumulates at a depth of 1 to 2 feet and then, in areas where this soil slopes, moves downhill. This causes seepy spots part of the way down the slope in some places, and in other places it wets a large part of the slope. Because of the difficulty of controlling erosion and at the same time providing adequate drainage, a combination of terracing and tiling is needed. (Capability unit IIIe–2; woodland suitability group 7)

Dickinson Series

The Dickinson series consists of dark-colored, somewhat excessively drained soils. These are nearly level to gently sloping soils on uplands and stream benches. They formed in 20 to 36 inches of sandy loam and the underlying loamy sand and sand. The loamy sand or sand extends to a depth of 4 feet or more. In places, depth to glacial till or limestone bedrock is 50 to 90 inches. Native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown fine sandy loam about 17 inches thick. The subsoil, which extends to a depth of about 36 inches, is brown fine sandy loam. The substratum is yellowish-brown loamy fine sand and fine sand that reach to a depth of 72 inches or more.

Dickinson soils have low to moderate available water capacity and moderately rapid permeability. They are very low in content of available phosphorus and potassium. These soils are acid in reaction and need lime unless they have been limed within the past 4 years. The sloping Dickinson soils are subject to erosion if they are cultivated.

Representative profile of Dickinson fine sandy loam, 2 to 5 percent slopes, 760 feet south and 67 feet west of northeast corner of SE¼ sec. 12, T. 99 N., R. 11 W., in a cultivated field on a slightly convex, south-facing slope of 4 percent:

Ap—0 to 7 inches, very dark brown (10YR 2/2) fine sandy loam; weak, fine, granular structure; very friable; neutral; clear, smooth boundary.

A1—7 to 11 inches, very dark brown (10YR 2/2) fine sandy loam; weak, medium, subangular blocky structure parting to weak, very fine, granular; very friable; slightly acid; gradual, smooth boundary.

A3—11 to 17 inches, very dark grayish-brown (10YR 3/2) fine sandy loam that has very dark brown (10YR 2/2) ped coatings; weak, medium, subangular blocky structure; very friable; medium acid; gradual, smooth boundary.

B1—17 to 27 inches, brown (10YR 4/3) fine sandy loam that has dark-brown (10YR 3/3) ped coatings; weak, medium, subangular blocky structure; very friable; strongly acid; gradual, smooth boundary.

B2—27 to 36 inches, brown (10YR 4/3) light fine sandy loam; weak, medium, subangular blocky structure; very friable; strongly acid; gradual, smooth boundary.

C1—36 to 54 inches, yellowish-brown (10YR 5/4) loamy fine sand; massive; loose; strongly acid; diffuse, smooth boundary.

C2—54 to 72 inches, light yellowish-brown (10YR 6/4) fine sand; few, fine, faint, yellowish-brown (10YR 5/6) and pale-brown (10YR 6/3) mottles; single grain; loose; strongly acid.

The A horizon generally is very dark brown (10YR 2/2) but ranges to very dark grayish brown (10YR 3/2). It is 10 to 20 inches thick. The B horizon is slightly acid to strongly acid. Depth to loamy sand or sand is 24 to 40 inches.

Dickinson soils formed in material similar to the parent material of the Ankeny, Lamont, and Sparta soils. They have a dark-colored A1 horizon that is thinner than that of Ankeny soils and a dark-colored A horizon that is thicker than that of Lamont soils. The Dickinson soils contain less sand in the A and B horizons than the Sparta soils.

Dickinson fine sandy loam, 0 to 2 percent slopes (175A).—This soil is on uplands and stream benches. Areas are about 2 to 10 acres in size. This soil generally is free of gravel.

Included in mapping in places are soils that contain a very small amount of gravel at a depth of less than 40 inches, and soils, mainly along the stream benches, that are gravelly sand below a depth of 40 inches. Also included are a few spots of soils that have a loam or loamy sand surface layer.

This soil is well suited to row crops when rainfall is normal and timely. It is somewhat excessively drained and is droughtly in some years. If cultivated, it is subject to slight soil blowing. The organic-matter content of this soil is moderate. (Capability unit IIIs-1; woodland suitability group 3)

Dickinson fine sandy loam, 2 to 5 percent slopes (175B).—This soil has the profile described as representative for the series. It is convex and commonly blends with the landscape of the uplands. Generally this soil is in areas adjacent to streams, but in a few places it is on stream benches and contains some gravel below a depth of 40 inches. Areas range from about 3 to 15 acres in size. This soil generally is free of gravel.

Included in mapping are areas of soils that contain a very small amount of gravel and a few spots of soils that have a surface layer of loam or loamy sand.

This soil is well suited to row crops when rainfall is normal and timely. It is somewhat excessively drained and is droughty. It is subject to slight soil blowing and water erosion if it is cultivated. The organic-matter content of this soil is moderate. (Capability unit IIIe-4; woodland suitability group 3)

Dickinson-Ostrander complex, 2 to 5 percent slopes (575B).—The soils of this complex are on ridges and the sides of ridges on uplands, and in most places they are near streams. They are dark-colored sandy loams and loams. Areas of this complex are generally made up of about 60 percent Dickinson soils and 40 percent Ostrander soils, but in places they are as much as 70 percent of either soil.

Included in mapping are small areas of Kenyon and Sparta soils.

These soils range from low to high in available water capacity and are moderately rapid to moderate in permeability. They are somewhat excessively drained and well drained. Reaction ranges from slightly acid to strongly acid. These soils need lime if they have not been limed within the past 4 years.

These soils vary in their suitability for row crops, but generally they are well suited to that use when rainfall is normal and timely. The organic-matter content in these soils is moderate to high. (Capability unit IIe-4; woodland suitability group 3)

Dickinson-Racine complex, 2 to 5 percent slopes (576B).—The soils of this complex are on ridges and the sides of ridges on uplands. In most places they are near streams. These soils are dark- and light-colored sandy loams and moderately dark colored loams. Areas of this complex generally are made up of about 60 percent Dickinson soils and about 30 percent Racine soils, but some areas are as much as 70 percent of either soil.

Included in mapping are a few areas where gravel is at or near the surface and small areas of Lamont and Bassett soils.

These soils range from low to high in available water capacity and from moderately rapid to moderate in permeability. They are somewhat excessively drained to well drained. Reaction ranges from slightly acid to strongly acid. These soils need lime if they have not been limed within the past 4 years.

Although these soils vary in their suitability for row crops, they are well suited to that use when rainfall is normal and timely. (Capability unit IIe-4; woodland suitability group 3)

Donnan Series

The Donnan series consists of moderately dark colored, moderately well drained to somewhat poorly drained, nearly level to gently sloping soils on uplands. These soils are in convex areas in downslope positions or on ridge crests that are lower than the high areas on the adjacent landscape. Slopes are short. These soils formed in 20 to 40 inches of loamy material and the underlying extremely firm, fine-textured, grayish, weathered glacial till. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam 7 inches thick. The subsurface layer is brown and yellowish-brown, friable loam about 10 inches thick. The upper part of the subsoil extends to a depth of 31 inches. It is mottled, yellowish-brown friable heavy sandy loam and sandy loam. The lower part of the subsoil extends to a depth of 51 inches and is extremely firm, gray and dark-gray silty clay mottled with strong brown and yellowish brown. The substratum is mottled dark-gray, light brownish-gray, light olive-brown, and yellowish-brown firm loam.

Donnan soils have high available water capacity. They are moderately permeable in the upper part but very slowly permeable in the lower part. They are very low in content of available phosphorus and potassium and moderate in content of organic matter. These soils are acid and need lime if they have not been limed within the past 5 years.

Providing adequate drainage and at the same time controlling erosion is difficult because the two measures conflict to some extent. Contouring and terracing slow the movement of surface water and let more of it soak into the soil. The extra water that enters the soil complicates drainage, especially in wet years.

Representative profile of Donnan loam, 2 to 5 percent slopes, 560 feet west and 140 feet north of the southeast corner of SW¼NE¼ sec. 34, T. 99 N., R. 12 W., in a cultivated field on a convex northeast-facing slope of 2½ percent:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; moderate, fine, granular structure; friable; few, fine, soft, dark-brown (7.5YR 3/2) oxides; strongly acid; clear, smooth boundary.

A21—7 to 11 inches, brown (10YR 4/3) loam; few, fine, faint, very dark grayish-brown (10YR 3/2) mottles; weak, medium, platy structure; friable; few, fine, soft, dark-brown (7.5YR 3/2) oxides; few fine specks of very dark gray (10YR 3/1); very strongly acid; clear, wavy boundary.

A22—11 to 17 inches, yellowish-brown (10YR 5/4) loam that has light olive-brown (2.5Y 5/4) ped coatings; weak, fine and very fine, subangular blocky structure; friable; very strongly acid; clear, wavy boundary.

B1—17 to 26 inches, yellowish-brown (10YR 5/6) heavy sandy loam that has yellowish-brown (10YR 5/4) ped coatings; few, fine, distinct, strong-brown (7.5YR 5/8) mottles in lower 2 inches; weak, medium, subangular blocky structure; very friable; few, fine, firm, strong-brown (7.5YR 5/8) oxides that have black (10YR 2/1) interiors; very strongly acid; clear, wavy boundary.

B21—26 to 31 inches, mottled yellowish-brown (10YR 5/4) and light gray (5Y 6/1) heavy loam; weak, medium, subangular blocky structure; firm; common, fine, soft, strong-brown (7.5YR 5/8) oxides; very strongly acid; abrupt, wavy boundary.

IIB22t—31 to 34 inches, gray (5Y 5/1) light silty clay; common, fine, faint, grayish-brown (2.5Y 5/2) mottles and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, fine, prismatic structure parting to moderate, fine, subangular blocky; extremely firm; thin discontinuous clay films; silt and sand coatings on prisms and peds when dry; very strongly acid; clear, wavy boundary.

IIB23t—34 to 41 inches, dark-gray (N 4/0) light silty clay; moderate, fine, prismatic structure parting to strong, fine and very fine, angular and subangular blocky; extremely firm; thin discontinuous clay films; nearly continuous silt and sand coatings on prisms and peds; few, fine, soft, strong-brown (7.5YR 5/8) oxides; strongly acid; clear, wavy boundary.

IIB24—41 to 48 inches, dark-gray (5Y 4/1) silty clay; few, fine, distinct, brown (10YR 4/3) oxides; moderate, fine, prismatic structure parting to moderate, fine, angular and subangular blocky; extremely firm; few, fine, soft, yellowish-red (5YR 5/6) oxides; strongly acid; clear, wavy boundary.

IIB3—48 to 51 inches, mottled dark-gray (5Y 4/1) and yellowish-brown (10YR 5/6) heavy silty clay loam; weak, fine, prismatic structure parting to weak, medium, subangular blocky; very firm; few, fine, soft, yellowish-red (5YR 5/6) oxides; strongly acid; clear, wavy boundary.

IIC1—51 to 57 inches, mottled dark-gray (5Y 4/1), light brownish-gray (2.5Y 6/2), and yellowish-brown (10YR 5/8) clay loam and silt loam; massive; firm; slightly acid; abrupt, wavy boundary.

IIIC2— 57 to 78 inches, mottled light brownish-gray (2.5Y 6/2) and light olive-brown (2.5Y 5/4) heavy loam; massive; firm; few, fine, firm, black (10YR 2/1) oxides; neutral; abrupt, wavy boundary.

IIIC3—78 to 92 inches, yellowish-brown (10YR 5/8) loam; common, fine, distinct, grayish-brown mottles; massive; firm; few vertical root channels lined with very dark gray (N 3/0) clay films; neutral; clear, wavy boundary.

In uncultivated areas the A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick. The A, Ap, and A2 horizons generally are loam but range to silt loam, some of which contains enough sand to have a gritty feel. Depth to the fine-textured IIB horizon ranges from 20 to 40 inches. Texture of the IIB2 horizon generally is silty clay but ranges to heavy clay loam and clay. Thickness of the clayey horizons ranges from 20 to 60 inches. The B horizon ranges from medium acid to very strongly acid in the most acid layer. The C horizon ranges from clay loam to loam.

Most of these soils in Howard County are outside the range defined for the series because the argillic horizon does not start in material I. This difference does not alter their usefulness or behavior.

Donnan soils are in a drainage class similar to that of Lourdes and Riceville soils. They contain more clay and have a firmer consistence in the IIB horizon than Lourdes and Riceville soils. They have colors of higher chroma in the A2 and B1 horizons than Riceville soils.

Donnan loam, 0 to 2 percent slopes (782A).—This soil is on ridge crests and the short, lower, slightly convex sides of ridges. It is associated with many soils, but Schley soils are the most common associates. Most of the areas are 2 to 4 acres in size, but a few are as large as 7 acres. In a few places the depth to the gray silty clay layer is more than 40 inches. In places there is a layer of pebbles and sand at the contact of the loamy overburden and the glacial till.

This soil is moderately well suited to row crops, except in wet years. The difference in permeability between the loamy overburden and the clayey subsoil causes water to accumulate at the contact surface. This accumulation produces a perched water table in spring or in other wet periods. Because of the very slow permeability of the underlying silty clay, tile drains may not function satisfactorily in all areas. If the silty clay is at a depth that allows tile to be placed above it, the tile drains are more likely to be satisfactory. (Capability unit IIw-3; woodland suitability group 7)

Donnan loam, 2 to 5 percent slopes (782B).—This soil has the profile described as representative for the series. It is on ridge crests and the short, convex sides of ridges. It is associated with many soils, but Schley soils are the most common associates. Most of the areas are 2 to 7 acres in size, but a few are as large as 35 acres. In a few places the depth to the gray clay layer is more than 40 inches, and in a very few places it is less than 20 inches.

This soil is moderately well suited to row crops, except in wet years. If cultivated, it is subject to slight erosion. Most of the acreage is cultivated, and use of this soil is determined by use of the surrounding soils.

Providing adequate drainage and at the same time controlling erosion are difficult because the two measures conflict to some extent. Erosion-control practices slow the movement of surface water and let more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. For this reason, a combination of terracing and tile drainage may be needed. Because of the very slow permeability of the subsoil, tile drainage may not drain all areas satisfactorily, and careful placement is very important. If the clayey subsoil is deep enough, tile may be placed above it with satisfactory results. (Capability unit IIe-2; woodland suitability group 7)

Downs Series

The Downs series consists of moderately dark colored, gently sloping to moderately steep, well-drained, silty soils on uplands. These soils are confined dominantly to the northeastern part of the county where the landscape is generally quite rolling. They formed in thick loess. Native vegetation was trees and grass.

In a representative profile the surface layer is very dark grayish-brown silt loam about 7 inches thick. The subsoil is dark yellowish-brown and yellowish-brown light silty clay loam and heavy silt loam that extends to a depth of 48 inches. The substratum is yellowish-brown, friable silt loam.

Downs soils are moderately permeable and have high available water capacity. They are medium in phosphorus and very low in available potassium. These soils are

acid, and they need lime unless they have been limed within the past 5 years.

The main management needs in farming are maintaining a high level of fertility and controlling erosion. The long slopes on uplands are well suited to contour cultivation and terracing. In places, alinement of terraces can be greatly improved by making cuts and fills and by changing gradient. The subsoil that is exposed by terracing generally responds to treatment more readily than that of most other soils in the county.

Representative profile of Downs silt loam, 5 to 9 percent slopes, moderately eroded, 257 feet south and 75 feet west of the northeast corner of NE1/4 sec. 14, T. 100 N., R. 11 W., in a cultivated field on a convex, northwest-facing slope of 5 percent:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

B21t—7 to 12 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; discontinuous dark-brown (10YR 3/3) clay films on ped faces; weak, fine, subangular blocky structure; friable; few very dark grayish-brown (10YR 3/2) clay films in root channels; slightly acid; clear, smooth boundary.

B22t—12 to 18 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; ped faces are slightly darker than the interiors and have many dark-brown (7.5YR 3/2) clay films on their faces; few silt coatings on ped faces in lower part of horizon; very strongly acid; clear, smooth boundary.

B23t—18 to 24 inches, yellowish-brown (10YR 5/4) light silty clay loam that has nearly continuous dark yellowish-brown (10YR 4/4) ped coatings; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; friable; many gray silt coatings when dry; few patches of dark-brown (7.5YR 3/2) clay films on prism and ped faces; very strongly acid; gradual, smooth boundary.

B31t—24 to 38 inches, yellowish-brown (10YR 5/4) heavy silt loam that had discontinuous dark yellowish-brown (10YR 4/4) ped coatings; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; friable; many gray silt coatings when dry; few, patchy, dark-brown (7.5YR 3/2) clay films on prism and ped faces; very strongly acid; gradual boundary.

B32—38 to 48 inches, yellowish-brown (10YR 5/4) heavy silt loam; few, fine, faint, strong-brown (7.5YR 5/6) mottles and common, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, coarse, platy structure; few, patchy, dark-brown (7.5YR 3/2) clay films on prism faces and in a few pores and root channels; friable; few, distinct, gray silt coatings when dry; strongly acid; gradual boundary.

C—48 to 61 inches, yellowish-brown (10YR 5/4) silt loam; massive; friable; few, fine, soft, yellowish-red (5YR 5/8) oxide concretions that have dark-red (2.5YR 3/6) interiors; medium acid.

In uncultivated and uneroded areas, the A1 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and is 5 to 8 inches thick. The A2 horizon in uncultivated areas ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3) and is 3 to 6 inches thick. In cultivated areas it may be wholly incorporated in the plow layer and evident only by grayish-brown coatings. In the B horizon the most clayey horizon ranges from heavy silt loam to light silty clay loam. Reaction generally is strongly acid or very strongly acid in the subsoil, but it is medium acid in places. Depth to carbonates is generally 6 feet or more.

Downs soils formed in material similar to the parent material of Fayette and Port Byron soils. They have a dark-colored A horizon that is thicker than that of Fayette soils, but they have a dark-colored A horizon that is thinner than that of Port Byron soils.

Downs silt loam, 2 to 5 percent slopes (162B).—This soil has a profile similar to the one described as representative for the series, except that it has a dark grayish-brown to brown subsurface layer that is 3 to 6 inches thick. In most areas this soil is confined to the tops of rather broad divides above the moderately sloping to steep Downs soils. Areas range from 2 acres to about 30 acres in size.

Included in mapping are a few spots of eroded soils that have a surface layer of very dark grayish brown to dark brown. A few included soils have a very dark gray surface layer that is 1 to 4 inches thick. Also included were a few areas of soils where limestone bedrock is within 30 to 50 inches of the surface; these areas are shown by a special spot symbol on the soil map.

This soil is well suited to row crops. It is subject to slight erosion if it is cultivated. It is well suited to contouring and terracing in most places. The organic-matter content is moderate. (Capability unit IIe–1; woodland suitability group 4)

Downs silt loam, 5 to 9 percent slopes (162C).—This soil has a profile similar to the one described as representative for the series, except that it has a dark grayish brown to brown subsurface layer 3 to 6 inches thick. In uncultivated areas the surface layer ranges from very dark brown to very dark gray and is 5 to 8 inches thick. This soil occupies the tops of divides and the sides of ridges. In most places it is above areas of more sloping Downs soils. Areas range from 2 acres to about 15 acres in size.

Included in mapping in places are a few spots of eroded soils that have a very dark grayish-brown to dark-brown surface layer. Also included in a few places are areas of soils that have limestone bedrock within 30 to 50 inches of the surface. These are shown on the soil map by a symbol. In addition, some areas of included soils, especially adjacent to waterways, have a very dark brown surface layer that is 10 to 20 inches thick.

This soil is well suited to row crops grown in the county. If cultivated, this soil is subject to moderate to severe erosion. Fields that are terraced can be used more frequently for row crops, because soil loss is not so great. (Capability unit IIIe–1; woodland suitability group 4)

Downs silt loam, 5 to 9 percent slopes, moderately eroded (162C2).—This soil has the profile described as representative for the series. It is on the tops of divides and the sides of ridges. In most places it is above areas of the more sloping Downs soils. Areas range from 2 acres to about 50 acres in size, and they are by far the most extensive areas of Downs soils in the county. This soil is lower in content of organic matter and available potassium than the uneroded Downs soils.

Included in mapping in places are small spots of severely eroded soils that have a surface layer of dark yellowish-brown heavy silt loam to light silty clay loam.

Most of the acreage of this Downs soil is cultivated.

This soil is well suited to row crops. Tilth generally is good, but the soil puddles and becomes cloddy if it is worked when wet. If cultivated, this soil is subject to severe erosion. The organic-matter content is moderately

low. (Capability unit IIIe–1; woodland suitability group 4)

Downs silt loam, 9 to 14 percent slopes, moderately eroded (162D2).—This soil has a profile similar to the one described as representative for the series; in areas where numerous waterways extend up the slope, however, the surface layer of the soil adjacent to the waterways is somewhat thicker and darker colored and the soil on the nose of slopes is severely eroded. These severely eroded areas are generally dark yellowish-brown heavy silt loam to light silty clay loam. They are lower in content of organic matter than less eroded Downs soils. These areas are indicated by a spot symbol. In most places this soil is on the sides of ridges below areas of the more gently sloping Downs soils and above the Radford and Huntsville soils. Some areas are above moderately steep Downs and Sogn soils and extend over the crests on narrow divides. Areas are about 2 to 15 acres in size.

Included in mapping in a few places are soils that have limestone bedrock within 30 to 50 inches of the surface. In spots the limestone bedrock outcrops. Most of these outcrops are shown on the soil map by a symbol. Also included are areas of uneroded soils in trees and permanent pasture.

This soil is well suited to row crops. Tilth generally is good, but the soils puddles and becomes cloddy if it is worked when wet. If cultivated, the soil is subject to severe erosion. The organic matter content is moderately low. (Capability unit IIIe–1; woodland suitability group 4)

Downs silt loam, 14 to 20 percent slopes, moderately eroded (162E2).—This soil has a profile similar to the one described as representative for the series. In areas where numerous waterways extend up the slope, however, the surface layer of the soil adjacent to the waterways is somewhat thicker and darker colored. The soil in such areas has severely eroded spots on the nose of the slopes. These eroded spots are dominantly dark yellowish-brown heavy silt loam to light silty clay loam that is lower in content of organic matter than the soil in less eroded areas. In most places this soil is downslope from other Downs soils, and it is generally dissected by small waterways. Areas are about 2 to 14 acres in size.

Included in mapping in a few places are soils that have limestone bedrock within 30 to 50 inches of the surface. In spots the limestone bedrock outcrops. Most of these outcrops are shown on the soil map by a symbol. Also included are some areas of uneroded soils in trees and permanent pasture.

This soil is moderately well suited to row crops. Tilth generally is good, but the soil puddles and becomes cloddy if it is worked when wet. If cultivated, this soil is subject to very severe erosion. It is well suited to hay and pasture. Occasionally, however, it can be used for row crops in rotation with hay if it is tilled on the contour. The organic-matter content of this soil is moderately low. (Capability unit IVe–1; woodland suitability group 4)

Fayette Series

The Fayette series consists of light-colored, well-drained, moderately sloping to steep, silty soils on generally rolling uplands. It is dominantly in the northeast corner of the county. These soils formed in thick loess. Native vegetation was trees.

In a representative profile the surface layer is very dark gray silt loam 3 inches thick. The subsurface layer is very dark grayish-brown and brown silt loam about 8 inches thick. The subsoil, which extends to a depth of 67 inches, is dark yellowish-brown and yellowish-brown light silty clay loam and heavy silt loam. The substratum is yellowish-brown silt loam.

Fayette soils are moderately permeable and have high available water capacity. Available phosphorus is high, and available potassium is very low. The content of organic matter is low. Reaction is acid. The soil needs lime unless it has been limed within the past 5 years. In places, alinement of terraces can be greatly improved by cuts and fills and by changes in gradient. The subsoil that is exposed by terracing generally responds to treatment more readily than that of many other soils in the county.

Representative profile of Fayette silt loam, 5 to 9 percent slopes, 720 feet west and 45 feet south of the northeast corner of SE¼ sec. 13, T. 100 N., R. 11 W., in open timber on a convex, south-facing slope of 5 percent:

A1—0 to 3 inches, very dark gray (10YR 3/1) silt loam; black (10YR 2/1) ped coatings; moderate, fine, granular structure; friable; medium acid; clear, smooth boundary.

A21—3 to 5 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry; very dark gray (10YR 3/1) ped coatings, gray to light gray (10YR 6/1) when dry; moderate, thin, platy structure; friable; few light-gray (10YR 7/2) silt coatings when dry; medium acid; clear, wavy boundary.

A22—5 to 11 inches, brown (10YR 4/3) silt loam, pale brown (10YR 6/3) when dry; nearly continuous very dark grayish-brown (10YR 3/2) ped coatings in upper part becoming discontinuous as depth increases; light-gray (10YR 7/2) silt coatings when dry; moderate, thin, platy structure; friable; medium acid; clear, wavy boundary.

B1—11 to 20 inches, dark yellowish-brown (10YR 4/4) medium silt loam; nearly continuous brown (10YR 4/3) ped coatings; light-gray (10YR 7/2) and very pale brown (10YR 7/3) silt coatings when dry; moderate, fine and very fine, subangular blocky structure; friable; strongly acid; gradual, smooth boundary.

B21t—20 to 31 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; discontinuous brown (10YR 4/3) prism and ped coatings, light-gray (10YR 7/2) silt coatings when dry; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; few, patchy, dark yellowish-brown (10YR 3/4) clay films on ped faces; strongly acid; gradual, smooth boundary.

B22t—31 to 43 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; friable; discontinuous dark yellowish-brown (10YR 3/4) clay films on prism faces and lining pores and root channels and a few patchy films on ped faces; discontinuous light-gray (10YR 7/2) silt coatings on prism and ped faces when dry; strongly acid; gradual, smooth boundary.

B31t—43 to 50 inches, yellowish-brown (10YR 5/6) heavy silt loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few, patchy, dark yellowish-brown (10YR 3/4) clay films on prism and ped faces and lining pores and root channels; discontinuous light-gray (10YR 7/2) silt coatings on prism faces when dry; strongly acid; gradual, smooth boundary.

B32t—50 to 67 inches, yellowish-brown (10YR 5/6) heavy silt loam; weak, medium, prismatic structure; friable; few, patchy, dark yellowish-brown (10YR 3/4) clay films on prism faces and lining pores and root channels; discontinuous very pale-brown (10YR 7/3) silt

coatings on prism faces when dry; medium acid; gradual, smooth boundary.

C—67 to 78 inches, yellowish-brown (10YR 5/6) silt loam; massive; friable; medium acid; gradual, smooth boundary.

In uncultivated areas the A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) and is 1 to 4 inches thick. In cultivated areas the plow layer is dark grayish brown (10YR 4/2) or brown (10YR 4/3). The A2 horizon generally is dark grayish brown (10YR 4/2), but it ranges to very dark grayish brown (10YR 3/2) to brown (10YR 5/3). Thickness of the A2 horizon ranges from 3 to 8 inches. In places the whole A2 horizon is incorporated into the plow layer. The B2 horizon ranges from heavy silt loam to light silty clay loam. Reaction in the most acid horizon generally is strongly acid, but it ranges from medium acid to very strongly acid. Depth to carbonates is more than 70 inches.

Fayette soils formed in material similar to the parent material of Downs and Port Byron soils. They have a dark-colored A horizon that is thinner than that of Downs or Port Byron soils.

Fayette silt loam, 5 to 9 percent slopes (163C).—This soil has the profile described as representative for the series. It is on the tops of divides and the sides of ridges. In most places it is above areas of the more sloping Fayette and Downs soils. Areas are about 2 to 20 acres in size. Much of this soil is covered by trees. In the few cultivated areas, the plow layer is dark grayish brown, and where the soil is eroded, the plow layer is brown or dark grayish brown.

This soil is well suited to row crops. It is subject to moderate to severe erosion if it is cultivated. Because of the uniformity of shape and the length of slopes, most areas are suitable for terracing. (Capability unit IIIe-1; woodland suitability group 4)

Fayette silt loam, 9 to 14 percent slopes (163D).—This soil is mainly on the sides of ridges below areas of the more gently sloping Fayette soils and above areas of steep Fayette or Sogn soils. In areas where this soil is adjacent to Radford and Huntsville soils in the drainageways, numerous small waterways extend up the slope. Areas are about 2 to 25 acres in size. Most of the acreage is covered by trees. In cultivated areas the plow layer is dark grayish brown. Where the soil is eroded, the plow layer is brown to dark grayish brown.

This soil is well suited to row crops. It is subject to moderate to severe erosion if it is cultivated. (Capability unit IIIe-1; woodland suitability group 4)

Fayette silt loam, 14 to 20 percent slopes (163E).—This soil is mainly on the sides of ridges below other Fayette soils, and generally it is dissected by small waterways. Areas are about 2 to 20 acres in size. Most of the acreage is covered by trees. In the cleared and cultivated areas, there is more erosion and the plow layer is dark grayish brown to brown. In a few places limestone bedrock is at a depth of 30 to 50 inches, and in places it outcrops. Most of these outcrops are shown on the soil map by a symbol.

This soil is moderately well suited to poorly suited to row crops. It is subject to severe erosion if it is cultivated. Except for areas that presently support good stands of trees, this soil is better suited to hay and pasture than to other crops. Occasionally, however, it can be used for row crops in rotation with meadow. (Capability unit IVe-1; woodland suitability group 4)

Fayette silt loam, 20 to 30 percent slopes (163F).—This soil is on the sides of ridges below other Fayette and Downs soils. In most places it is on the breaks to the major drainageways and is generally dissected by waterways. Areas are about 2 to 20 acres in size. Most of this soil is in areas covered by trees. In some areas the dark surface layer is 4 to 7 inches thick. There are a few places where the slopes are steeper, and there are a few limestone outcrops.

This soil is poorly suited to row crops. Because of the steep slopes and the very severe hazard of erosion, this soil should be used for cultivated crops only in a renovation program to reestablish a grass-legume pasture. On the steep slopes, however, regular farm machinery cannot safely be used. (Capability unit VIe-1; woodland suitability group 5)

Floyd Series

The Floyd series consists of dark-colored, somewhat poorly drained soils on uplands. These soils are slightly convex to concave and have slopes of 1 to 4 percent in coves. They formed in 30 to 45 inches of loamy material and the underlying medium-textured and moderately coarse textured, friable sediment and glacial till. In places there is a layer of pebbles at the contact surface of the sediment and the glacial till. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown loam about 15 inches thick. The subsoil extends to a depth of 57 inches. It is very dark grayish-brown to olive-brown, yellowish-brown, and strong-brown loam and sandy loam that has some mottles. The substratum is mottled strong-brown and gray, firm loam.

Floyd soils have high available water capacity and moderate permeability. They are very low in available phosphorus and potassium. In most places these soils are slightly acid to neutral. These soils are wet, at least in part, because of hillside seepage from the Kenyon soils that commonly occur upslope. If drained, these soils commonly are used for row crops; if not drained, they are in pasture.

Representative profile of Floyd loam, 1 to 4 percent slopes, 820 feet north and 315 feet of the southeast corner of sec. 3, T. 97 N., R. 12 W., in a cornfield on east-facing slope of 1 percent:

Ap—0 to 8 inches, black (N 2/0) heavy loam; moderate, fine, granular structure; friable; few roots; slightly acid; abrupt, smooth boundary.

A1—8 to 12 inches, black (10YR 2/1) heavy loam; moderate, fine and very fine, granular structure; friable; neutral; clear, smooth boundary.

A3—12 to 15 inches, very dark grayish-brown (2.5Y 3/2) heavy loam; nearly continuous black (10YR 2/1) ped coatings; weak, fine, subangular blocky structure parting to moderate, fine and very fine, granular; friable; neutral; clear, wavy boundary.

B11—15 to 19 inches, very dark grayish-brown (2.5Y 3/2) heavy loam; few, fine, faint, dark grayish-brown (2.5Y 4/2) and olive-brown (2.5Y 4/4) mottles; nearly continuous very dark gray (5Y 3/1) ped coatings; moderate, fine and very fine, subangular blocky structure; friable; very few pebbles; neutral; clear, wavy boundary.

B12—19 to 25 inches, mottled, olive-brown (2.5Y 4/4) and dark grayish-brown (2.5Y 4/2) loam; few, fine, faint, light olive-brown (2.5Y 5/6) mottles; discontinuous dark grayish-brown (2.5Y 4/2) ped coatings; mod-

erate, fine, subangular blocky structure; friable; very few pebbles; neutral; clear, smooth boundary.

B21—25 to 34 inches, yellowish-brown (10YR 5/6) sandy loam; few, fine, faint, strong-brown (7.5YR 5/8) mottles; nearly continuous brown (10YR 5/3) ped coatings; weak, medium, subangular blocky structure; very friable; pebble band in upper part of horizon; few, fine, soft, dark reddish-brown (5YR 2/2) oxides; neutral; clear, smooth boundary.

IIB22—34 to 42 inches, strong-brown (7.5YR 5/6) heavy loam; few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; nearly continuous grayish-brown (2.5Y 5/2) prism coatings and discontinuous ped coatings; moderate, medium, prismatic structure parting to moderate, medium and weak, fine, subangular blocky; firm; few pebbles; neutral; gradual, smooth boundary.

IIB31—42 to 51 inches, mottled strong-brown (7.5YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; discontinuous grayish-brown (2.5Y 5/2) ped exteriors; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; few pebbles; few, fine, soft, yellowish-red (5Y 5/8) oxides; neutral; clear, smooth boundary.

IIB32—51 to 57 inches, yellowish-brown (10YR 5/6) medium sand; very weak, medium, subangular blocky structure; very friable; few pebbles; neutral; clear, smooth boundary.

IIC1—57 to 72 inches, mottled strong-brown (7.5YR 5/6) and gray to light-gray (5Y 6/1) heavy loam; massive; firm; few pebbles; neutral; abrupt, wavy boundary.

IIC2—72 to 78 inches, mottled strong-brown (7.5YR 5/6) and gray to light-gray (5Y 6/1) heavy loam; massive; firm; few pebbles; strongly effervescent; mildly alkaline.

The A1 horizon generally is black (10YR 2/1), but it ranges to very dark gray (10YR 3/1) or very dark grayish brown (2.5Y 3/2) in the lower part and is 12 to 20 inches thick. Generally the texture is loam, but it ranges to silt loam, light clay loam, and light silty clay loam that contain enough sand to feel gritty in places. Thickness of the stratified loamy sediment over the glacial till ranges from 30 to 45 inches. Texture in material II is variable but generally is loam, sandy clay loam, or light clay loam that has horizontal lenses or pockets of sand and sandy loam. Reaction generally is neutral, and the depth to carbonates ranges from 50 to 80 inches.

Floyd soils formed in materials similar to the parent material of Clyde, Schley, and Lawler soils. They are not so poorly drained as the Clyde soils and have a higher chroma in the A3 horizon and in the upper part of the B horizon. Floyd soils have a dark-colored A horizon that is thicker than that of Schley soils and are less acid. They do not have sand and gravel substrata below a depth of about 24 to 40 inches as do the Lawler soils.

Floyd loam, 1 to 4 percent slopes (198B).—This soil is downslope from the Kenyon, Cresco, and Bassett soils and upslope from the Clyde soils. In some areas this soil is closely associated with the Clyde soils along narrow upland drainageways, and they are not shown separately on the soil map. Areas of this soil commonly are 3 to 20 acres in size, and they are generally narrow. Most areas extend across more than one farm.

Included in mapping are soils that have clay loam glacial till below a depth of 40 inches in places. Also included are a very few places where the soils are dark, compacted silt below a depth of 40 inches.

This soil is well suited to row crops if it is drained. The major limitation is wetness, but in some areas some soil is lost through erosion. Because wetness, at least in part, is a result of sidehill seepage, a drainage system that intercepts this lateral movement of water is the most effective one. In areas where erosion is a concern, a combination of terracing and tile drainage can be used. The organic-matter content is high. (Capability unit IIw–2; woodland suitability group 8)

Hayfield Series

The Hayfield series consists of moderately dark colored, somewhat poorly drained, nearly level soils on stream benches. These soils formed in 24 to 40 inches of medium-textured alluvial deposits and the thick layers of underlying coarse-textured material. Native vegetation was prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is 6 inches of olive-brown, friable loam that has a few grayish-brown mottles. The subsoil extends to a depth of 60 inches. It is mottled olive-brown, grayish-brown and yellowish-brown gravelly loamy sand in the lower part.

Hayfield soils have moderate to low available water capacity. Permeability is moderate in the medium-textured material and rapid to very rapid in the coarse-textured substratum. These soils are low in content of available phosphorus and very low in content of available potassium. The content of organic matter is moderate. Reaction generally is acid, and these soils need lime if they have not been limed within the past 5 years.

Representative profile of Hayfield loam, deep, 423 feet north and 171 feet east of the southwest corner of sec. 17, T. 97 N., R. 14 W., in a level cultivated field:

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy loam; moderate, fine, granular structure; friable; few very small pebbles; medium acid; clear, smooth boundary.

A2—8 to 14 inches, olive-brown (2.5Y 4/4) loam; few, fine, distinct, dark grayish-brown (10YR 4/2) mottles; light-gray (10YR 7/2) ped coatings when dry; moderate, medium, platy structure; friable; very strongly acid; clear, wavy boundary.

B1—14 to 20 inches, olive-brown (2.5Y 4/4) heavy loam; few, fine, distinct, dark grayish-brown (2.5Y 4/2) mottles; discontinuous grayish-brown (2.5Y 5/2) ped coatings and few very dark grayish-brown (10YR 3/2) ped coatings; few light-gray (10YR 7/2) silt and sand coatings when dry; weak, medium, subangular blocky structure parting to moderate, very fine, subangular blocky; friable; few small pebbles; very strongly acid; gradual, smooth boundary.

B21t—20 to 27 inches, mottled dark yellowish-brown (10YR 4/4) and grayish-brown (2.5Y 5/2) heavy loam; few, fine, faint, dark grayish-brown (10YR 4/2) mottles; weak, medium, subangular blocky structure; friable; very few, soft, yellowish-red (5YR 4/6) oxides; few small pebbles; very strongly acid; gradual, smooth boundary.

B22t—27 to 32 inches, dark grayish-brown (10YR 4/2) loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky structure; very friable; clay bridging between sand grains; about 10 percent is fine gravel; very strongly acid; gradual, smooth boundary.

B23t—32 to 36 inches, grayish-brown (10YR 5/2) loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; discontinuous grayish-brown (2.5Y 5/2) ped coatings; weak, medium, subangular blocky structure; friable; clay bridging between sand grains; few, soft, reddish-brown (5YR 4/4) oxides; few small pebbles; very strongly acid; clear, smooth boundary.

IIB31—36 to 46 inches, grayish-brown (10YR 5/2) gravelly loamy sand; common, fine, distinct, yellowish-brown

mottles; very weak, medium, subangular blocky structure; very friable; few, soft, reddish-brown (5YR 4/4) oxides; strongly acid; clear, smooth boundary.

IIB32—46 to 60 inches, yellowish-brown (10YR 5/4) gravelly loamy sand; very weak, medium, subangular blocky structure; very friable; few, soft, dark-brown (7.5YR 3/2) and yellowish-red (5YR 4/6) oxides; medium acid.

In uncultivated areas the A1 horizon is black (10YR 2/1) to very dark gray (10YR 3/1) and is 5 to 7 inches thick. In cultivated areas the plow layer generally is very dark brown (10YR 2/2) but ranges to very dark grayish brown (10YR 3/2). The A1 or Ap horizon and the A2 horizon generally are loam but range to silt loam that includes enough sand to feel gritty. The B2 horizon ranges from loam to sandy clay loam but has a thin zone of sandy loam below a depth of 24 to 36 inches. Depth to the coarse texture ranges from 24 to 40 inches. Reaction ranges from medium acid to very strongly acid in the most acid horizon.

Hayfield soils in Howard County have a chroma of 2 in the upper part of the B horizon, which is outside the range defined for the series. This difference does not alter the usefulness or behavior of the soils.

Hayfield soils formed in material similar to the parent material of Lawler and Schley soils. They have a dark-colored A horizon that is thinner than that of Lawler soils. Hayfield soils are coarse textured in the lower part of the B horizon, but Schley soils are loamy textured.

Hayfield loam, deep (0 to 2 percent slopes) (726).—This soil has the profile described as representative for the series. It is on stream benches. It has sandy material at a depth of 36 to 40 inches. This soil is associated with Marshan, Lawler, Wapsie, and Sattre soils. Most areas are 3 to 10 acres in size, but a few are as large as 30 acres.

Included in mapping are a few small areas of soils that have coarse material at a depth near 45 inches and other areas where the coarse material is at a depth of as little as 30 inches. Also included are areas of soils that have a sandy surface layer. These areas are more droughty than is typical for this Hayfield soil.

This soil is well suited to row crops. It is somewhat poorly drained, and tile drainage is beneficial in wet periods. Very little of the acreage has been tiled, but in some years tile drainage would improve the timeliness of soil operations. Tile placement is difficult in some places because of loose, water-bearing sand. (Capability unit I–2; woodland suitability group 8)

Hayfield loam, moderately deep (0 to 2 percent slopes) (725).—This soil has a profile similar to the one described as representative for the series, except that it has sandy material at a depth of 24 to 30 inches. This nearly level soil is on stream benches. It is associated mainly with Wapsie, Saude, and Sattre soils. Most areas are 2 to 10 acres in size, but a few are as large as 20 acres.

Included in mapping are a few areas of soils that have a surface layer of sandy loam and some areas of soils that have coarse-textured material within 20 inches of the surface.

This soil is well suited to row crops. During extended dry periods it is somewhat droughty. This soil is somewhat poorly drained, and tile drainage is beneficial in wet periods. Very little of the acreage has been tiled, but in some years tile drainage would enhance the timeliness of fieldwork. Tile placement is difficult in some places because of loose, water-bearing sand. (Capability unit IIs–1; woodland suitability group 8)

Huntsville Series

The Huntsville series consists of dark-colored, well-drained, gently sloping soils on foot slopes of narrow upland valleys. These soils formed in silty alluvial deposits. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and dark-brown silt loam 34 inches thick. The subsoil is yellowish-brown silt loam that extends to a depth of more than 60 inches.

Huntsville soils have high available water capacity and are moderately permeable. They are medium in available phosphorus and low in available potassium. Reaction is neutral to slightly acid in the upper 20 to 30 inches and slightly acid to medium acid below. These soils are subject to sheet and gully erosion. They are well suited to row crops.

Huntsville soils are mapped only in an undifferentiated unit with Radford soils.

Representative profile of a Huntsville silt loam in an area of Radford and Huntsville silt loams, 460 feet west and 323 feet south of the northeast corner of sec. 16, T. 100 N., R. 11 W., in a pasture on a flat, east-facing slope of 3 percent:

Ap—0 to 8 inches, very dark brown (10YR 2/2) light silt loam that has black (10YR 2/1) ped coatings; very weak, fine, granular structure; very friable; neutral; clear, smooth boundary.

A1—8 to 27 inches, very dark brown (10YR 2/2) silt loam; black (10YR 2/1) and very dark brown (10YR 2/2) ped coatings; moderate, fine and very fine, granular structure; friable; neutral; gradual, smooth boundary.

A3—27 to 34 inches, dark-brown (10YR 3/3) silt loam; dark-brown (10YR 3/3) and very dark grayish-brown (10YR 3/2) ped coatings; weak, medium and fine, subangular blocky structure; friable; medium acid gradual, smooth boundary.

B21—34 to 42 inches, yellowish-brown (10YR 5/4) heavy silt loam; weak, fine, prismatic structure parting to weak, fine and medium, subangular blocky; friable; very few, thin, patchy, dark-brown (10YR 3/3) clay films on prism and ped faces and in pores and root channels; few light-gray (10YR 7/2) silt coatings when dry; medium acid; gradual, smooth boundary.

B22—42 to 53 inches, yellowish-brown (10YR 5/4) heavy silt loam; moderate, fine, prismatic structure parting to weak, medium, subangular blocky; friable; few dark-brown (10YR 3/3) clay films on prism and ped faces and few very dark grayish-brown (10YR 3/2) clay films in pores and root channels; light-gray (10YR 7/2) silt coats on prism faces and on a few ped faces when dry; few, fine, dark reddish-brown (5YR 2/2) and strong-brown (7.5YR 5/6) oxides; medium acid; gradual, smooth boundary.

B3—53 to 73 inches, yellowish-brown (10YR 5/4) heavy silt loam; weak, fine, prismatic structure parting to weak, medium, subangular blocky; friable; few light-gray (10YR 7/2) silt coatings when dry; very few dark yellowish-brown (10YR 3/4) clay films in pores and root channels; common, fine, dark reddish-brown (5YR 2/2) and strong-brown (7.5YR 5/6) oxides; medium acid.

The A horizon generally is very dark brown (10YR 2/2), but it ranges to black (10YR 2/1) and very dark grayish brown (10YR 3/2). Thickness of the dark-colored material ranges from 24 to 36 inches. The B horizon is light silt loam to heavy silt loam. Mottles in some places are below a depth of 30 inches. Reaction is slightly acid to medium acid in the most acid horizon.

Huntsville soils in Howard County that are medium acid in the lower part of the control section are outside the

range defined for the series, but this does not alter the usefulness or behavior of the soils.

Huntsville soils formed in material similar to the parent material of Radford, Spillville, and Turlin soils. They lack the stratification of the Radford soils. They contain less sand and more silt than the Spillville and Turlin soils.

Jacwin Series

The Jacwin series consists of dark-colored, somewhat poorly drained, nearly level soils on uplands. These soils are dominantly in low areas on the landscape, but in a few places they are in high areas. They formed in 20 to 30 inches of loamy material and the underlying fine-textured shales. Native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark gray, friable silty clay loam 15 inches thick. The upper part of the subsoil is dark grayish-brown light clay loam that has some mottling. The lower part of the subsoil, below a depth of about 22 inches, is olive and olive-gray, firm silty clay that is mildly alkaline to moderately alkaline.

Jacwin soils have high available water capacity. They are moderately permeable in the overburden and very slowly permeable in the shale. As a result, water accumulates at the contact surface of these two materials and causes a high water table. On the slope, water moves downward along the contact line and causes hillside seepage. These soils are low in content of available phosphorus and potassium. Organic-matter content is high. Reaction in most places is slightly acid to neutral.

Wetness is one of the major limitations to cultivation. Because permeability is very slow in the shaly subsoil, depth and spacing of tile lines are very important. Tile may not drain all areas satisfactorily. The root growth of some plants is limited by the shale near the surface.

Representative profile of Jacwin silty clay loam, 0 to 2 percent slopes, 332 feet west and 253 feet north of the southeast corner of NW¼NW¼ sec. 1, T. 99 N., R. 12 W., in a level cultivated field:

Ap—0 to 7 inches, black (N 2/0) light silty clay loam; clods parting to moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A1—7 to 11 inches, black (N 2/0) light silty clay loam; weak, medium, subangular blocky structure parting to moderate, fine, granular; friable; neutral; clear, smooth boundary.

A3—11 to 15 inches, very dark gray (10YR 3/1) silty clay loam; common, fine, faint, very dark grayish-brown (2.5Y 3/2) mottles; weak, medium, subangular blocky structure parting to moderate, fine, granular; friable; neutral; clear, smooth boundary.

B21—15 to 22 inches, dark grayish-brown (2.5Y 4/2) clay loam; common, fine, faint, light olive-brown (2.5Y 5/4) mottles; continuous grayish-brown (2.5Y 5/2) ped coatings; moderate, fine, subangular blocky structure; firm; band of pebbles ½ inch to 4 inches in diameter at base of horizon; few, very fine, soft, strong-brown (7.5YR 5/8) oxides; mildly alkaline; clear, smooth boundary.

IIB22—22 to 27 inches, olive (5Y 5/3) silty clay; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, prismatic structure parting to moderate, fine, angular blocky and very fine, subangular blocky; very firm; very few, fine, strong-brown (7.5YR 5/8) oxides; mildly alkaline; clear, wavy boundary.

IIB3—27 to 44 inches, olive-gray (5Y 5/2) silty clay, pale olive (5Y 6/4) kneaded; common, fine, distinct, yellowish-brown (10YR 5/6) mottles, light olive-brown (2.5Y 5/4) and greenish-gray (5G 6/1) mottles; weak, medium, prismatic structure parting to moderate, medium, angular blocky; very firm; few more limey segregations between depths of 31 and 36 inches; violently effervescent; moderately alkaline.

Thickness of the loamy overburden ranges from 20 to 30 inches. The A horizon generally is silty clay loam but ranges to heavy loam that contains enough sand in places to feel gritty. The B horizon above the shale ranges from silty clay loam or loam to heavy sandy loam that contains enough sand to feel gritty. In the upper part of the B horizon, colors range from dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) to light olive brown (2.5Y 5/4). The IIB horizon ranges from olive brown (2.5Y 4/4) to olive gray (5Y 5/2) or olive (5Y 5/4) and is mottled. In some places there is a thin layer of sandy or gravelly material less than 8 inches thick directly above the shale. Shattered limestone bedrock in some places is at a depth below 40 inches, but in most places it is at a depth of 60 to 120 inches or more.

Jacwin soils formed in material similar to the parent material of the Winneshiek soils, shaly subsoil variant. They have a dark-colored A horizon that is thicker and colors that are lower in chroma in the B and IIB horizons than the Winneshiek soils, shaly subsoil variant.

Jacwin silty clay loam, 0 to 2 percent slopes (444).—This soil is mostly in low-lying, benchlike areas on uplands. In most places it is associated with soils that are underlain by limestone. Much of it is located within 2 miles of Bonair. Most areas are 3 to 5 acres in size, but a few are more than 80 acres.

Included in mapping, particularly in the low area about 1 mile west of Bonair, are a few areas of soils that have a shale substratum that begins at a depth of 30 to 50 inches. Also included are a few areas of soils that are wetter and have a grayer subsoil than this Jacwin soil. In a small area in a high position on the upland about 1 mile west of Cresco is a soil that has a somewhat thinner, lighter colored surface layer; reaction of this soil is more acid than is typical of Jacwin soils.

This soil is well suited to row crops if it is tile drained. Tilth generally is good, but the soil puddles if it is worked when wet. It is seasonally wet because of a high water table, and fieldwork is often delayed unless tile drains have been installed. Tile drains should not be placed too deep in the shale, and backfill should be made of porous material. Tile may not drain all areas satisfactorily. (Capability unit IIw-3; woodland suitability group 7)

Jameston Series

The Jameston series consists of dark-colored, poorly drained soils on uplands. These soils are at the heads of drainageways and along the upper parts of some drainageways. They formed in 18 to 30 inches of loamy material and the underlying very firm clay loam glacial till. In most places a layer of pebbles and stones is at the contact line of the overburden and the glacial till. Slopes are nearly level and slightly concave. Native vegetation was mixed prairie grasses and sedges.

In a representative profile the surface layer is black silty clay loam 18 inches thick. The upper part of the subsoil, which extends to a depth of 25 inches, is dark olive-gray, olive-brown, and dark grayish-brown friable silty clay loam and loam. Below a depth of 25 inches, the subsoil is mottled gray and yellowish-brown, firm and very firm clay loam. The substratum is mottled dark

yellowish-brown and light-gray, very firm clay loam that is mildly alkaline.

Jameston soils have high available water capacity and slow permeability. They are very low in content of available phosphorus and potassium. Organic-matter content is high. These soils generally are neutral but range from midly alkaline to slightly acid. They are wet, at least in part, because of hillside seepage from the Cresco and Protivin soils that commonly occur upslope. Placement and spacing of tile in Jameston soils are very important because of the slowly permeable subsoil.

Representative profile of Jameston silty clay loam 840 feet north and 73 feet east of the southeast corner of NW 1/4 sec. 11, T. 99 N., R. 13 W., in an uncultivated field on a concave, east-facing slope of 1 percent:

A11—0 to 8 inches, black (N 2/0) mucky light silty clay loam; moderate, fine, granular structure; very friable; slightly acid; clear, smooth boundary.

A12—8 to 14 inches, black (N 2/0) light silty clay loam; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A3—14 to 18 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B1g—18 to 22 inches, dark olive-gray (5Y 3/2) silty clay loam; few, fine, distinct, olive-brown (2.5Y 4/4) mottles; very weak, fine, subangular blocky structure; firm; few, very fine, soft, dark-brown (7.5YR 4/4) oxides; neutral; clear, smooth boundary.

IIB21g—22 to 25 inches, mottled dark grayish-brown (2.5Y 4/2) and olive-brown (2.5Y 4/4) heavy loam; discontinuous dark-gray (5Y 4/1) ped coatings; weak, fine, subangular blocky structure; friable; few, fine, soft, strong-brown (7.5YR 5/6) oxides; pebble band at top of horizon; neutral; clear, smooth boundary.

IIB22tg—25 to 34 inches, mottled yellowish-brown (10YR 5/6) and gray (5Y 5/1) light clay loam; discontinuous dark-gray (5Y 4/1) and gray (5Y 5/1) prism and ped coatings; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; few root channels filled with dark-gray (5Y 4/1) clay; few small pebbles; neutral; gradual, smooth boundary.

IIB23tg—34 to 42 inches, mottled gray (5Y 5/1) and yellowish-brown (10YR 5/6) clay loam; nearly continuous gray (5Y 5/1) prism coatings and few gray (5Y 5/1) ped coatings; moderate, medium, prismatic structure parting to weak, medium, subangular blocky; very firm; few dark-gray (5Y 4/1) clay films on prism and ped faces and in a few root channels; gray (5Y 5/1) very fine sand and silt grains line most pore channels; few small pebbles; mildly alkaline; clear, wavy boundary.

IIB3tg—42 to 53 inches, mottled gray (5Y 5/1) and yellowish brown (10YR 5/6) medium clay loam; very weak, coarse, prismatic structure parting to very weak, coarse, subangular blocky; very firm; few very dark gray (10YR 3/1) clay films in pores and root channels; few small pebbles; strongly effervescent, mildly alkaline; gradual, smooth boundary.

IIC1—53 to 66 inches, mottled dark yellowish-brown (10YR 4/4) and light-gray (5Y 6/1) medium clay loam; massive; very firm; very few yellowish-red (5YR 4/8) and dark reddish-brown (5YR 2/2) oxides; few small pebbles; strongly effervescent; mildly alkaline; diffuse, smooth boundary.

IIC2—66 to 82 inches, mottled gray (N 5/0) and dark yellowish-brown (10YR 4/4) medium clay loam; massive; very firm; strongly effervescent, mildly alkaline.

The A horizon generally is light silty clay loam, but it ranges to light clay loam and, in places, mucky silt loam. In some areas the soil contains enough sand to have a gritty feel. Color generally is black (10YR 2/1) or very dark gray (10YR 3/1), and thickness ranges from 12 to 20 inches. Depth to very firm clay loam till ranges from 18 to 30 inches. Texture of the IIB and IIC horizons centers on clay loam, and content of clay ranges from 28 to 35 percent. Reaction in the solum generally is neutral, but it ranges from slightly acid to mildly alkaline. Depth to carbonates ranges from 36 to 50 inches.

Jameston soils formed in material similar to the parent material of Tripoli and Protivin soils. They contain more clay and have a firmer consistence in the lower part of the subsoil and substratum than Tripoli soils. They are more poorly drained and have yellower hues in the B1 horizon than Protivin soils.

Jameston silty clay loam (0 to 2 percent slopes) (797).—In most places this soil is at the upper end of drainageways. In the bottoms of the drainageways, it is almost level and in most places water flows very slowly through the drainageways. This soil is associated with the Cresco, Lourdes, Protivin, and Riceville soils upslope and with Clyde soils farther down the drainageways. Most areas are about 3 to 15 acres in size. They are not very wide, but they generally extend across more than one farm.

This soil is well suited to row crops if it is properly drained. In undrained areas it is better suited to pasture than to most other uses. The major limitation is wetness. Because the wetness is a result, at least in part, of hillside seepage from the Cresco and Protivin soils, a drainage system that is designed to intercept laterally moving water is the most effective one. Permeability of the subsoil is slow; consequently, the depth and spacing of tile are very important. Large granite boulders are common in some areas and need to be removed before the soil can be cropped. (Capability unit IIw-1; woodland suitability group 10)

Kenyon Series

The Kenyon series consists of dark-colored, moderately well drained soils on uplands. These soils are nearly level to gently sloping on long ridge crests and gently sloping to moderately sloping on convex sides of ridges. These soils formed in 13 to 22 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones is between the loamy overburden and the glacial till. In most places a layer of pebbles and stones is between the loamy overburden and the glacial till. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and dark-brown loam about 16 inches thick. The subsoil is dominantly yellowish-brown heavy loam that is mottled with grayish brown and strong brown between depths of 25 and 52 inches. The substratum is mottled yellowish-brown and grayish-brown loam.

Kenyon soils have high available water capacity. They are moderately permeable in the upper part and moderately slowly permeable in the lower part. Water moves more rapidly through the friable, loamy overburden than through the firm glacial till. This causes water to accumulate at their contact surface and results in wet, seepy areas in some years. These soils are very low in content of available phosphorus and potassium. They commonly are acid in reaction and need lime unless they have been limed within the past 5 years. The eroded Kenyon soils are lower in content of organic matter and available potassium than the uneroded Kenyon soils.

Providing adequate drainage and at the same time controlling erosion are difficult because these two measures conflict to some extent. The sloping soils on long, uniform, ridge crests are well suited to contour cultivation and terracing. These practices slow the movement of surface water and let more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years.

Representative profile of Kenyon loam, 2 to 5 percent slopes, 1,220 feet east and 78 feet south of the northwest corner of SW 1/4 NW1/4 sec. 25, T. 98 N., R. 14 W., in a cultivated field on a convex, southeast-facing slope of 3 percent:

Ap—0 to 6 inches, black (10YR 2/1) loam; clods parting to weak, fine and medium, subangular blocky structure; friable; medium acid; abrupt, smooth boundary.

A1—6 to 10 inches, black (10YR 2/1) loam; fine, granular structure; friable; medium acid; clear, smooth boundary.

A3—10 to 16 inches, dark-brown (10YR 3/3) loam; discontinuous, very dark grayish-brown (10YR 3/2) ped coatings; medium, subangular blocky structure parting to moderate, fine, granular; friable; medium acid; clear, smooth boundary.

IIB21—16 to 25 inches, yellowish-brown (10YR 4/4) heavy loam; moderate, fine and medium, subangular blocky structure; friable; pebble band at a depth of 16 to 18 inches; a few small pebbles throughout; strongly acid; gradual, smooth boundary.

IIB22—25 to 30 inches, yellowish-brown (10YR 5/6) heavy loam; few, fine, distinct, grayish-brown (2.5Y 5/2) mottles and few, fine, faint, strong-brown (7.5YR 5/8) mottles; discontinuous brown (10YR 5/3) ped coatings; moderate, fine and medium, subangular blocky structure; friable; few small pebbles; strongly acid; clear, smooth boundary.

IIB23—30 to 43 inches, mottled dark yellowish-brown (10YR 4/4), strong-brown (7.5YR 5/6), and grayish-brown (2.5Y 5/2) heavy loam; nearly continuous grayish-brown (2.5Y 5/2) prism coatings; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; few small pebbles; few, discontinuous, dark grayish-brown (10YR 4/2) clay films in root channels; few, soft, black (10YR 2/1), and reddish-brown (5YR 4/4) oxides; strongly acid; gradual, smooth boundary.

IIB3—43 to 52 inches, mottled yellowish-brown (10YR 5/4) and grayish-brown (2.5Y 5/2) heavy loam; few, fine, faint, strong-brown (7.5YR 5/6 and 5/8) mottles; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; firm; few small pebbles; few dark-gray (N 4/0) clay films in root channels; slightly acid; gradual, smooth boundary.

IIC—52 to 71 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; massive; firm; few small pebbles; few, small, soft, reddish-yellow (5YR 4/8) oxides; neutral; clear, wavy boundary.

The A1 horizon ranges from 7 to 16 inches in thickness and from black to very dark grayish brown (10YR 3/2) in color. Texture generally is loam but ranges to silt loam that has a high content of sand. Depth to grayish mottles ranges from 20 to 34 inches. In the B horizon the texture generally is heavy loam, but it ranges from loam or sandy clay loam to light clay loam. Thickness of the loamy overburden over the glacial till ranges from 13 to 22 inches. The B horizon is medium acid to strongly acid in the most acid horizon, and reaction becomes less acid below a depth of about 3 feet. Depth to carbonates is 45 to 80 inches.

Kenyon soils formed in material similar to the parent material of Bassett, Cresco, and Ostrander soils. They have a dark-colored A horizon that is thicker than that of Basset soils. They are more friable and contain less clay in the IIB horizon than Cresco soils. Kenyon soils have a IIB2 horizon that is less friable than that of Ostrander soils. They also contain a few grayish mottles that are lacking in Ostrander soils.

Kenyon loam, 2 to 5 percent slopes (83B).—This soil has the profile described as representative for the series. It is on long, convex ridgetops and the sides of ridges and is generally upslope from the Floyd soils. In most places areas are 4 to 20 acres in size, but they range from 2 to 60 acres.

Included in mapping are small spots of eroded soils that have a dark-brown surface layer and small spots of sandy soils that are shown on the soil map by a symbol.

This soil is well suited to row crops. It is subject to slight erosion if it is cultivated. Because of the difference in permeability of the loamy overburden and the underlying glacial till, which is at a depth of about 1½ feet, water accumulates at their contact surface and produces a temporary high water table, particularly early in spring. To control erosion and at the same time provide adequate drainage, a combination of terracing and tile drainage is needed in places. The organic-matter content in this soil is high. (Capability unit IIe–1; woodland suitability group 6)

Kenyon loam, 5 to 9 percent slopes (83C).—This soil is on rather short, convex side slopes below gently sloping Kenyon soils. Most areas are near larger streams and range from 2 acres to about 5 acres in size.

Included in mapping are small spots of eroded soils that have a brown surface layer and a few spots of sandy soils that are shown on the soil map by a symbol.

This soil is well suited to row crops. It is subject to moderate to severe erosion if it is cultivated. In wet seasons fieldwork may be delayed slightly. To control erosion and at the same time provide adequate drainage, a combination of terraces and tile drainage is needed in places. The organic-matter content of this soil is high. (Capability unit IIIe–1; woodland suitability group 6)

Kenyon loam, 5 to 9 percent slopes, moderately eroded (83C2).—This soil has a profile similar to the one described as representative for the series, except that the surface layer is mixed with material from the subsoil. This soil has rather short, convex slopes and is below gently sloping Kenyon soils. Most areas are near the larger streams and are 4 acres to about 5 acres in size. The glacial till is 10 to 14 inches below the surface and is exposed in a few severely eroded spots. The eroded soils are lower in content of organic matter and available potassium than the uneroded Kenyon soils.

Included in mapping are a few spots of sandy soils in places, and these are shown on the soil map by a special symbol.

This soil is well suited to row crops. It is subject to severe erosion if it is cultivated. In wet seasons fieldwork is delayed slightly. To control erosion and at the same time provide adequate drainage, a combination of terraces and tile drainage is needed in places. The organic-matter content of this soil is moderate. (Capability unit IIIe–1; woodland suitability group 6)

Lamont Series

The Lamont series consists of light-colored, somewhat excessively drained soils. These nearly level to moderately sloping soils are on uplands adjacent to streams and on

stream benches. They formed in about 20 to 40 inches of sandy loam and loamy sand or sand. Native vegetation was trees.

In a representative profile the surface layer is very dark brown fine sandy loam 4 inches thick. The subsurface layer is brown, very friable sandy loam that is 10 inches thick. The subsoil, which extends to a depth of more than 70 inches, is brown, yellowish-brown, and strong-brown sandy loam that grades to loamy sand with depth.

Lamont soils have to low to moderate available water capacity. Permeability is moderately rapid. Available phosporus is medium, and available potassium is very low. These soils are acid and need lime unless they have been limed within the past 4 years. The more sloping soils are highly erodible. The lack of moisture is a limitation in most years.

Representative profile of Lamont fine sandy loam, 2 to 5 percent slopes, 970 feet east and 440 feet south of the northwest corner of SW 1/4 sec. 36, T. 99 N., R. 11 W., in timber on a southeast-facing slope of 3 percent:

A1—0 to 4 inches, very dark brown (10YR 2/2) fine sandy loam; moderate, very fine, subangular blocky structure; very friable; strongly acid; clear, wavy boundary.

A21—4 to 10 inches, brown (10YR 4/3) light fine sandy loam; dark grayish-brown (10YR 4/2) ped coatings; pale-brown (10YR 6/3) grainy coatings when dry; very weak, medium, platy structure parting to weak, fine, subangular blocky; very friable; strongly acid; clear, wavy boundary.

A22—10 to 14 inches, brown (10YR 5/3) light sandy loam; few dark grayish-brown (10YR 4/2) ped coatings; few pale brown (10YR 6/3) sand coatings when dry; weak, medium, subangular blocky structure; very friable; strongly acid; clear, wavy boundary.

B1—14 to 19 inches, brown (10YR 4/3) heavy sandy loam; weak, fine and medium, subangular blocky structure; very friable; few, thin, discontinuous, pale-brown (10YR 6/3) sand coatings when dry; strongly acid; clear, wavy boundary.

B21t—19 to 25 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam; discontinuous, dark-brown (10YR 3/3) clay films on ped faces; thin, discontinuous, pale-brown (10YR 6/3) sand coatings when dry; moderate, fine, subangular blocky structure; friable; strongly acid; clear, wavy boundary.

B22t—25 to 29 inches, yellowish-brown (10YR 5/4) light sandy loam; weak, medium, subangular blocky structure; very friable; few, thin, discontinuous, brown (10YR 4/3) clay films; medium acid; clear, wavy boundary.

B31—29 to 40 inches, yellowish-brown (10YR 5/6) loamy sand; weak, coarse, subangular blocky structure; very friable; occasional dark yellowish-brown ped coatings; medium acid; abrupt, wavy boundary.

B32t—40 to 45 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam; weak, medium, subangular blocky structure; very friable; few, patchy, brown (10YR 4/3) clay films; strongly acid; abrupt, smooth boundary.

B33—45 to 52 inches, strong-brown (7.5YR 5/8) light loam; few, fine, distinct, brown (10YR 5/3) mottles and few, fine, faint, yellowish-red (5YR 4/6) mottles; weak, coarse, subangular blocky structure; very friable; about 10 percent is pebbles 1/8 inch to 3 inches in diameter; strongly acid; gradual, smooth boundary.

B34—52 to 70 inches, strong-brown (7.5YR 5/6) loamy sand; common, medium, faint, yellowish-red (5YR 4/6) mottles and few, medium, distinct, brown (10YR 5/3) mottles; very weak, medium, subangular blocky structure; very friable; very few pebbles; strongly acid.

In uncultivated areas the A1 horizon is very dark gray (10YR 3/1) to very dark brown (10YR 2/2) fine sandy loam 3 to 6 inches thick. In cultivated areas the plow layer is dark grayish brown (10YR 4/2) and is about 6 to 8 inches thick. The A2 horizon is 6 to 12 inches thick, but in some cultivated or eroded areas it is wholly incorporated into the Ap horizon. The B2 horizon generally is sandy loam but ranges from light sandy loam to heavy sandy loam. Dark-brown to brown (7.5YR 4/4) clay-iron bands, ½ inch to 2 inches thick, are present in some profiles below a depth of 40 inches. Reaction ranges from medium acid to very strongly acid in the most acid horizon.

Lamont soils formed in material similar to the parent material of the Dickinson, Backbone, and Sparta soils. They have a dark-colored A horizon that is thinner than that of Dickinson and Sparta soils and contain less sand in the solum than the Sparta soils. Lamont soils do not have a solum that terminates on limestone bedrock as do the Backbone soils.

Lamont fine sandy loam, 0 to 2 percent slopes (110A).—This soil is principally on stream benches, but there are a few areas of it on uplands just south of Cresco. Areas are about 3 to 12 acres in size.

Included in mapping are a few areas of cultivated soils that have a very dark brown surface layer and a few areas of soils that have a surface layer of loamy fine sand. The texture of this soil is slightly coarser on benches than it is on uplands. Also included in a few places on benches are soils that have gravel below a depth of 40 inches. A few areas of included soils on uplands have glacial till below a depth of 30 to 40 inches.

This soil is well suited to row crops if rainfall is normal and timely. It is somewhat excessively drained and is slightly droughty. This soil is subject to slight soil blowing if it is cultivated. The organic-matter content in this soil is low. (Capability unit IIIs-1; woodland suitability group 3)

Lamont fine sandy loam, 2 to 5 percent slopes (110B).—This soil has the profile described as representative for the series. On uplands, this soil has convex slopes and generally is in areas adjacent to streams. On benches, it generally is in low, long, moundlike areas along streams or it is on narrow escarpments. Areas are about 3 to 7 acres in size. This soil generally is free of gravel, but in a few places it has a few pebbles. In a few areas this soil has a surface layer of loamy fine sand. The surface layer in uncultivated areas is somewhat darker colored and thinner.

Included in mapping are a few areas of cultivated soils that have a very dark brown surface layer. On the uplands are a few spots of included soils that have glacial till at a depth of 30 to 40 inches. Also included in a few places on benches are soils that have gravelly material below a depth of 40 inches.

This soil is well suited to row crops if rainfall is normal and timely. It is somewhat excessively drained and is droughty. This soil is subject to slight soil blowing and water erosion if it is cultivated. The organic-matter content in this soil is low. (Capability unit IIIe-4; woodland suitability group 3)

Lamont fine sandy loam, 5 to 9 percent slopes (110C).—This soil is on convex areas on ridgetops and on the sides of ridges. It is mainly in the northeastern part of the county and in most places is near a stream. It is associated with the Winneshiek and Downs soils. Areas are about 2 to 5 acres in size. In uncultivated areas the surface layer

501-192—74——3

is somewhat darker colored and thinner. This soil generally is free of gravel, but in some areas there are a few pebbles. In a few places the surface layer is loamy fine sand.

This soil is moderately well suited to row crops. It is somewhat excessively drained and is droughty. If cultivated this soil is subject to soil blowing and water erosion. Organic-matter content in this soil is very low. (Capability unit IIIe-4; woodland suitability group 3)

Lawler Series

The Lawler series consists of dark-colored, somewhat poorly drained, level to nearly level soils on stream benches. These soils formed in 24 to 40 inches of medium-textured alluvial deposits and underlying thick layers of coarse-textured material. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black loam about 23 inches thick. It grades to very dark grayish brown in the lower part. The upper part of the subsoil, which extends to a depth of 37 inches, is dark grayish-brown and olive-brown loam and sandy clay loam that has some mottles. The lower part of the subsoil is brown, light olive-brown, and strong-brown gravelly loamy sand that extends to a depth of 60 inches.

Lawler soils have moderate to low available water capacity. Permeability is moderate in the medium-textured material and rapid to very rapid in the coarse-textured substratum. Available phosphorus is low, and available potassium is very low. Organic-matter content is high. Most of these soils range from medium acid to slightly acid, and they should be limed if this has not been done within the past 5 years. In the northeastern part of the county, these soils are neutral to slightly acid and lime generally is not needed.

Representative profile of Lawler loam, deep, 380 feet east and 115 feet north of the southeast corner of SW¼ sec. 31, T. 98 N., R. 11 W., in a meadow on a south-facing slope of 1 percent:

Ap—0 to 7 inches, black (10YR 2/1) heavy loam; moderate, fine and very fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A12—7 to 13 inches, black (10YR 2/1) heavy loam; moderate, fine, granular structure; friable; medium acid; gradual, smooth boundary.

A13—13 to 19 inches, very dark gray (10YR 3/1) heavy loam; black (10YR 2/1) ped coatings; moderate, fine and very fine, subangular blocky structure; friable; medium acid; clear, wavy boundary.

A3—19 to 23 inches, very dark grayish-brown (2.5Y 3/2) heavy loam; discontinuous very dark gray (10YR 3/1) ped coatings; moderate, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B21—23 to 28 inches, dark grayish-brown (2.5Y 4/2) clay loam; very dark grayish-brown (10YR 3/2) ped coatings; weak, fine, subangular blocky structure; friable; few small pebbles; few, small, soft, yellowish-brown (10YR 5/6) oxides; medium acid; gradual, smooth boundary.

B22—28 to 37 inches, olive-brown (2.5Y 4/4) light sandy clay loam; discontinuous dark grayish-brown (2.5Y 4/2) ped coatings; few, fine, faint, light olive-brown (2.5Y 5/6) mottles; weak, medium, subangular blocky structure; few pebbles ⅛ inch to 1 inch in diameter; medium acid; abrupt, smooth boundary.

IIB3—37 to 60 inches, stratified layers of gravelly loamy sand that ranges from brown (10YR 4/3) to light olive brown (2.5Y 5/4) and strong brown (7.5YR 5/6); common, fine, soft oxides that range from dark reddish brown (2.5YR 2/4) to strong brown (7.5YR 5/6); weak, coarse, subangular blocky structure; very friable; medium acid; about 15 percent is gravel.

The A horizon generally is loam but ranges to light clay loam and silt loam that contains enough sand to feel gritty. The B horizon generally ranges from loam to sandy clay loam and light clay loam, but it contains a thin zone of sandy loam at a depth below 24 to 36 inches. Depth to coarse textures of gravelly loamy sand or coarse sand is 24 to 40 inches. The B horizon is slightly acid to medium acid in the most acid horizon. Depth to calcareous material is more than 70 inches.

Lawler soils formed in material similar to the parent material of the Hayfield and Floyd soils. They have a dark-colored A horizon that is thicker than that of Hayfield soils. Lawler soils have a coarser texture in the lower horizons than the Floyd soils.

Lawler loam, deep (0 to 2 percent slopes) (226).—This soil is on stream benches. Most areas are 3 to 10 acres in size, but a few are as large as 25 acres.

Included in mapping are a few small areas of soils that have coarse materials at somewhat deeper or more shallow depths. Also included are a few spots of sandy or wet soils that are shown on the soil map by a symbol.

This soil is well suited to row crops. It is somewhat poorly drained and benefits from tile drainage in wet periods. Only a very small acreage has been tiled. Tile placement is difficult in some places because of the loose, unstable sand. (Capability unit I-2; woodland suitability group 8)

Lawler loam, moderately deep (0 to 2 percent slopes) (225).—This soil has a profile similar to the one described as representative for the series, except that sandy and gravelly material is at a depth of 24 to 30 inches. This soil is on stream benches. It is associated with many other bench soils. Most areas are 3 to 10 acres in size, but a few are as large as 25 acres.

Included in mapping are spots of sandy and wet soils that are shown on the soil map by a special symbol.

This soil is well suited to row crops. In extended dry periods it is somewhat droughty. It is somewhat poorly drained, and tile drainage is beneficial in wet seasons. Only a very small acreage has been tiled. Tile placement is difficult in some places because of the loose, unstable sand. (Capability unit IIs-1; woodland suitability group 8)

Lilah Series

The Lilah series consists of moderately dark colored, excessively drained, nearly level to strongly sloping soils on stream benches and in upland outwash areas. These soils formed in 10 to 20 inches of sandy loam that contains a few pebbles and is underlain by gravelly and sandy materials. Native vegetation was trees.

In a representative profile the surface layer generally is very dark grayish-brown sandy loam that is about 6 inches thick and contains a few pebbles. The subsoil, which extends to a depth of 39 inches, is brown, very friable gravelly sandy loam that grades with depth to strong-brown gravelly loamy sand and sand. The substratum is strong-brown loamy sand that has a small amount of gravel.

Lilah soils have very low available water capacity. Permeability is rapid. These soils are very low in available phosphorus and potassium. They are acid and need lime unless they have been limed within the past 4 years.

Representative profile of Lilah sandy loam, 3 to 9 percent slopes, 215 feet south and 96 feet east of the northwest corner of SW¼ sec. 15, T. 100 N., R. 13 W., in a grassy field on a convex, west-facing slope of 5 percent:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) sandy loam; moderate, fine and very fine, subangular blocky structure; very friable; about 6 percent is fine gravel; medium acid; abrupt, smooth boundary.

B1—6 to 9 inches, dark yellowish-brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/4) when dry; weak, fine, subangular blocky structure; very friable; many very dark grayish-brown (10YR 3/2) worm casts; pale-brown (10YR 6/3) sand coatings when dry; about 6 percent is fine gravel; strongly acid; clear, wavy boundary.

B2t—9 to 15 inches, brown (7.5YR 4/4) gravelly sandy loam; discontinuous brown (10YR 4/3) ped coatings; very pale brown (10YR 7/3) sand coatings when dry; weak, fine, subangular blocky structure; very friable; clay bridging on sand grains and very few, thin, brown (7.5YR 4/4), patchy clay films on ped faces; about 20 percent is fine gravel; strongly acid; clear, smooth boundary.

IIB31t—15 to 28 inches, strong-brown (7.5YR 5/6) gravelly light loamy sand; brown (7.5YR 4/4) clay films on ped faces; very weak, coarse, subangular blocky structure; very friable; clay bridging between many sand grains; weakly cemented when dry; few, thin, 5- to 10-millimeter, horizontal lenses of brown (7.5YR 4/4) light sandy loam that has continuous clay films; about 18 percent is fine gravel; very strongly acid; clear, wavy boundary.

IIB32—28 to 39 inches, strong-brown (7.5YR 5/8) sand; very weak, coarse, subangular blocky structure; very friable; very weakly cemented when dry; thin, 3- to 8-millimeter, horizontal lenses of brown (7.5Y 4/4) loamy sand that has clay bridging at irregular intervals of ½ inch to 3 inches; about 7 percent is fine gravel; very strongly acid; clear, wavy boundary.

IIC—39 to 100 inches, strong-brown (7.5YR 5/8) loamy sand; single grain; loose; very strongly acid; very little gravel.

The A horizon generally is very dark grayish brown (10YR 3/2) or very dark brown (10YR 2/2) and is 6 to 9 inches thick. Its texture commonly is sandy loam that has some gravel, but it ranges to light loam and gravelly sandy loam. A dark grayish-brown (10YR 4/2) or brown (10YR 4/3) A2 horizon, 1 to 6 inches thick, is present in some places. The B2 horizon ranges from brown (10YR 5/3) to yellowish brown (10YR 5/6) or strong brown (7.5YR 5/3) and is 6 to 8 inches thick. It generally is sandy loam that has some gravel, but it ranges to light loam. Depth to contrasting textures ranges from 10 to 20 inches. The percentage of gravel, by volume, varies, but some strata are as much as 50 percent gravel. The greatest concentration of gravel-sized material is at a depth of less than 50 inches. The B horizon ranges from strongly acid to very strongly acid in the most acid horizon.

Lilah soils formed in material similar to the parent material of the Burkhardt and Lamont soils. They have a dark-colored A horizon that is thinner than that of the Burkhardt soils. They contain coarse sand and pebbles in the A and B horizons that are absent in the Lamont soils.

Lilah sandy loam, 0 to 3 percent slopes (776A).—This soil is mostly on stream benches, but a few small areas are about 2 to 10 acres in size.

Included in mapping in a few places are soils that have a surface layer of light loam and spots of soils that have gravelly material on the surface.

This soil is poorly suited to row crops. It is excessively drained and droughty, and if cultivated it is subject to slight soil blowing. The organic-matter content in this soil is low. (Capability unit IVs–1; woodland suitability group 1)

Lilah sandy loam, 3 to 9 percent slopes (776C).—This soil has the profile described as representative for the series. Most areas are on uplands, but some areas are on narrow bench escarpments. Areas are generally about 2 to 10 acres in size. In a few places the surface layer is light loam, and there are spots where gravelly material is on the surface. About 17 percent of this soil is moderately eroded and has a brown surface layer.

This soil is poorly suited to row crops. It is excessively drained and is droughtly. If cultivated it is subject to slight soil blowing and water erosion. The organic-matter content in this soil is low. (Capability unit IVs–2; woodland suitability group 1)

Lilah sandy loam, 9 to 14 percent slopes (776D).—This soil is on narrow bench escarpments and on uplands. Areas are 2 to 4 acres in size.

Included in mapping are a few areas of eroded soils that have a brown surface layer, and these generally contain gravelly materials.

This soil is poorly suited to row crops. It is excessively drained and is droughty. It is better suited to hay and pasture than to row crops. The organic-matter content in this soil is very low. (Capability unit VIs–1; woodland suitability group 1)

Lourdes Series

The Lourdes series consists of moderately dark colored, moderately well drained, gently sloping to moderately sloping soils on long, convex ridgecrests and the sides of ridges on uplands. These soils formed in 13 to 22 inches of loamy material and the underlying very firm clay loam glacial till. In most places a layer of pebbles and stones is at the contact surface of the overburden and glacial till. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam 8 inches thick. The subsurface layer is brown, friable loam 3 inches thick. The upper part of the subsoil, which extends to a depth of 18 inches, is yellowish-brown, friable and firm loam. The lower part of the subsoil reaches to a depth of 51 inches. It is strong-brown and light-gray, very firm clay loam that has a few grayish mottles and nearly continuous gray coatings on prism and block faces. The substratum is mottled, strong-brown and gray, very firm light clay loam that is mildly alkaline.

Lourdes soils have high available water capacity. They are very low in available phosphorus and potassium. The organic-matter content is moderate. Reaction is acid, and the soils need lime unless they have been limed within the past 5 years. Water moves more rapidly in the overburden than it does in the glacial till. This causes it to accumulate at the contact surface of these two materials and results in a seasonal perched water table and sidehill seeps in wet years. The upper 1 to 2 feet of these soils has moderate permeability, and below this permeability is slow.

The water table is perched at a depth of 20 to 24 inches in extended wet periods. Providing adequate drainage and

at the same time controlling erosion is difficult because the two measures conflict to some extent. The long, uniform slopes on uplands are well suited to contour cultivation and terracing. These practices, however, slow down the movement of surface water and let more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years.

Representative profile of Lourdes loam, 2 to 5 percent slopes, 255 feet south and 241 feet west of the northeast corner of sec. 32, T. 98 N., R. 12 W., in a meadow on a convex, east-facing slope of 3 percent:

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy loam, grayish brown (10YR 5/2) when dry; clods grading to weak, fine, granular structure; friable; medium acid; abrupt, smooth boundary.

A2—8 to 11 inches, brown (10YR 4/3) heavy loam, pale brown (10YR 6/3) when dry; moderate, medium, platy structure; friable; strongly acid; clear, wavy boundary.

B1—11 to 15 inches, yellowish-brown (10YR 5/4) heavy loam; brown (10YR 4/3) ped coatings; moderate, fine, subangular blocky structure; friable; few, fine, soft, strong-brown (7.5YR 5/6) oxides; very strongly acid; clear, smooth boundary.

IIB21—15 to 18 inches, yellowish-brown (10YR 5/6) heavy loam; nearly continuous brown (10YR 5/3) ped coatings; moderate to strong, very fine, subangular blocky structure; firm; few, fine, soft, strong-brown (7.5YR 5/6) oxides; band of pebbles 1 to 3 inches in diameter at surface; very strongly acid; clear, wavy boundary.

IIB22t—18 to 22 inches, strong-brown (7.5YR 5/8) light clay loam; nearly continuous light gray (5Y 6/1) prism and ped coatings; common, fine, distinct, light-gray (5Y 6/1) mottles that are concentrated around the pores; moderate, medium, prismatic structure parting to strong, fine, subangular blocky; very firm; few, very dark gray (N 3/0) and dark gray (N 4/0) clay films and streaks on prism and ped faces; few, very fine, soft, strong-brown (7.5YR 5/8) oxides; few pebbles; very strongly acid; clear, wavy boundary.

IIB23t—22 to 31 inches, mottled strong-brown (7.5YR 5/6) and light-gray (5Y 6/1) clay loam; continuous gray to light-gray (5Y 6/1) prism and ped coatings; moderate, medium and coarse, prismatic structure parting to moderate to strong, medium, subangular blocky; very firm; white (N 8/0) silt and sand coatings on prism faces when dry; common very dark gray (N 3/0) and dark-gray (N 4/0) clay films on prism and ped faces and filling some root channels; few pebbles; few, fine, soft, yellowish-red (5YR 5/8) oxides; strongly acid; clear, wavy boundary.

IIB31t—31 to 44 inches, mottled strong-brown (7.5YR 5/6) and light-gray (5Y 6/1) medium clay loam; nearly continuous gray (5Y 5/1) prism coatings; moderate, coarse, prismatic structure parting to weak, coarse, subangular blocky; very firm; few clay films; few pebbles; neutral; clear, wavy boundary.

IIB32t—44 to 51 inches, mottled strong-brown (7.5YR 5/6) and light-gray (5Y 6/1) medium clay loam; weak, medium, prismatic structure; very firm; discontinuous gray (5Y 5/1) prism coatings; black (N 2/0) clay films on prism faces and in pores and root channels; common hard lime concretions; few pebbles; strongly effervescent; mildly alkaline; gradual, smooth boundary.

IIC—51 to 76 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 5/1) light clay loam; massive; very firm; few hard lime concretions; mildly effervescent; mildly alkaline.

The A1 or Ap horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick, in eroded areas. Texture is generally loam but ranges to silt loam that contains enough sand to feel gritty. The A2 horizon ranges from brown (10YR 4/3) to dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) and from loam to silt loam that is 3 to 5 inches thick. In eroded areas the A2 horizon is wholly incorporated into the plow layer in places. Material I ranges from 13 to 22 inches in thickness. Maximum content of clay in the IIB2t horizon ranges from 30 to 35 percent. The IIC horizon ranges from 28 to 32 percent in content of clay. The upper part of the solum is generally strongly acid to very strongly acid, and the IIB horizon ranges from very strongly acid in the upper part to neutral or mildly alkaline in the lower part. Depth to calcareous glacial till ranges from 40 to 70 inches.

Lourdes soils formed in material similar to the parent material of the Cresco and Bassett soils. They have a dark-colored A horizon that is thinner than that of the Cresco soils. Lourdes soils contain more clay and have a firmer consistence in the IIB horizon than the Bassett soils.

Lourdes loam, 2 to 5 percent slopes (781B).—This soil has the profile described as representative for the series. It is on long, convex ridges and the sides of ridges. In most places it is upslope from the Riceville and Schley soils. Areas generally range from about 3 to 40 acres in size.

Included in mapping in places are small spots of eroded soils that have a brown or dark-brown surface layer and a few spots of sand that are shown on the soil map by a special symbol.

This soil is well suited to row crops. If cultivated it is subject to erosion. Because of the difference in permeability of the loamy overburden and of the underlying glacial till at a depth of about 1½ feet, water tends to accumulate at the contact surface of these two materials. This produces a temporary high water table, particularly early in spring. A combination of terracing and tile drainage is needed to provide adequate erosion control and drainage at the same time. Careful placement and spacing of tile are important because of the slowly permeable subsoil. (Capability unit IIe–2; woodland suitability group 7)

Lourdes loam, 5 to 9 percent slopes (781C).—This soil has rather short, convex slopes and is below the gently sloping Lourdes soils and above the Schley and Clyde soils. In most places areas are about 2 to 5 acres in size.

Included in mapping are a few moderately eroded areas of soils that have a dark grayish-brown to brown loam plow layer. In these eroded areas the till is 10 to 14 inches below the surface. Also included are small spots of sandy soils in some areas. These are shown on the soil map by a symbol.

This soil is moderately well suited to row crops. If cultivated, it is subject to moderate to severe erosion. This soil has a seasonal perched water table in places. It is generally at lower elevations than the other Lourdes soils, and water accumulates in it at a depth of 1 to 2 feet and then moves downhill. The water causes a seepy spot part way down the slope in places, and in other places it wets a large part of the slope. A combination of terracing and tiling is needed to provide adequate erosion control and drainage at the same time. (Capability unit IIIe–2; woodland suitability group 7)

Marsh

Marsh (354) occupies flat or depressional areas on first bottoms and on very low stream benches. Manmade marsh is on the lower stream benches between an artificial

pond or lake and the uplands. Marsh is intermixed with and includes ponds and intermittent ponds and shallow lakes. Marsh has a water table at or near the surface and is wet the year around. In areas that have been flooded since dams were built, the prairie grasses and trees have died or are dying. The natural vegetation now is cattails, rushes, sedges, and other water-tolerant grasses. (Capability unit VIIw-1; woodland suitability group 11)

Marshan Series

The Marshan series consists of dark-colored, poorly drained, nearly level soils on stream benches. These soils formed in 30 to 40 inches of moderately fine textured alluvial deposits underlain by thick layers of coarse-textured material. Native vegetation was prairie grasses, sedges, and other water-tolerant plants.

In a representative profile the surface layer is black and very dark gray clay loam 18 inches thick. The subsoil, which extends to a depth of 42 inches, is dark-gray and olive-gray silty clay loam and heavy loam that is mottled in the upper part. It is mottled, olive gray sandy loam and loamy sand in the lower part. The substratum begins at a depth of 42 inches and is mottled dark-gray and olive-gray gravelly loamy sand.

The Marshan soils have moderate available water capacity and are moderately permeable. They are very low in content of available phosphorus and potassium. The content of organic matter is high. In most places these soils are neutral in reaction.

Representative profile of Marshan clay loam, deep, 1,315 feet west and 485 feet south of the northeast corner of sec. 8, T. 98 N., R. 14 W., in a nearly level meadow:

Ap—0 to 8 inches, black (N 2/0) light clay loam; moderate, fine, subangular blocky structure parting to moderate, fine, granular; friable; neutral; clear, smooth boundary.

A1—8 to 16 inches, black (N 2/0) light clay loam; moderate, fine, granular structure; friable; few very small pebbles; neutral; clear, wavy boundary.

A3g—16 to 18 inches, very dark gray (10YR 3/1) light clay loam; few, fine, distinct, dark-gray (5Y 4/1) mottles; weak, fine, subangular blocky structure parting to moderate, fine, granular; friable; few very small pebbles; neutral; clear, wavy boundary.

B1g—18 to 23 inches, dark-gray (5Y 4/1) silty clay loam that is high in sand in upper part and grades to olive-gray (5Y 5/2) silty clay loam that is high in sand as depth increases; weak, firm, subangular blocky structure; friable; few, fine, soft, yellowish-brown (10YR 5/6) oxides; neutral; clear, wavy boundary.

B21g—23 to 30 inches, olive-gray (5Y 5/2) heavy loam; common, fine, prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; common, fine, soft, dark reddish-brown (5YR 3/4) oxides; few very small pebbles; neutral; clear, wavy boundary.

IIB22—30 to 38 inches, mottled olive-gray (5Y 5/2) and yellowish brown (10YR 5/6) heavy sandy loam; weak, medium, subangular blocky structure; friable; few small pebbles; neutral; clear, wavy boundary.

IIB3—38 to 42 inches, olive-gray (5Y 5/2) loamy sand that is about 15 percent fine gravel and has an admixture that is very dark gray (10YR 3/1) because of a krotovina; common, medium, prominent, yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; very friable; neutral; clear, smooth boundary.

IIIC1—42 to 49 inches, mottled dark-gray (5Y 4/1) and olive-gray (5Y 5/2) gravelly loamy sand; few, fine, prominent, yellowish-brown (10YR 5/6) mottles; massive; loose; neutral; clear, wavy boundary.

IIIC2—49 to 66 inches, olive-gray (5Y 5/2) gravelly loamy sand; massive; loose; few, coarse, prominent, yellowish-brown (10YR 5/6) mottles below a depth of 59 inches; neutral.

The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) and from light clay loam or loam to silty clay loam that contains enough sand to feel gritty. It is 16 to 24 inches thick. The B horizon ranges from loam, clay loam, or silty clay loam in the upper part to heavy sandy loam and loamy sand in the lower part. The C horizon ranges from gravelly loamy sand to sand that contains some gravel. Depth to contrasting textures ranges from 30 to 40 inches.

Marshan soils formed in material similar to the parent material of the Clyde and Lawler soils. They have a IIIC horizon of gravelly loamy sand, in contrast to the loam-textured IIIC horizon in the Clyde soils. The Marshan soils are more poorly drained than the Lawler soils and have a lower chroma in the upper part of the B horizon.

Marshan clay loam, deep (152).—This soil has the profile described as representative for the series. It is nearly level and is on stream benches. In a few places the sand or gravel is within 2 feet of the surface, but generally sandy material is below a depth of 36 inches. Depressions are in some places, and water ponds in these in wet periods. Undrained soils in some areas have a thin, mucky surface layer. This soil is associated with the Lawler, Waukee, Saude, Hayfield, and other soils on benches. The Colo or Turlin soils are commonly on the adjoining bottom lands. Most areas are 3 to 20 acres in size, but some are as much as 60 acres.

This soil is well suited to row crops if it is properly drained. Tilth generally is good, but the soil puddles if it is worked when wet. Artificial drainage is needed for good crop growth. This soil is subject to flooding for short periods when waters are exceptionally high. (Capability unit IIw-1; woodland suitability group 10)

Marshan clay loam, depressional (153).—This soil has a profile similar to the one described as representative for the series, except that in a few places the sand or gravel is at a depth of about 30 inches. This soil is in distinct, slightly concave areas and is seasonally ponded. Most of it has not been drained and is hummocky. More than 80 percent of the acreage is on benches along the Wapsipinicon and Little Wapsipinicon Rivers. This soil is associated with other Marshan soils and with Lawler, Waukee, and Saude soils.

This soil is moderately well suited to row crops if it is properly drained. Without tile drainage it is not suited to cultivated crops and does not make good pasture or hayfields. It is subject to floods of short duration. Water is within a few inches of the surface much of the year if tile drainage is not used. Surface drainage helps to remove the ponded water. (Capability unit IIIw-1; woodland suitability group 10)

Muck

Muck consists of dark-colored, very poorly drained, highly organic soil material that is 10 to 60 inches thick. It is underlain by stratified glacial till or alluvial sediment. These soils generally are nearly level to gently sloping and are mostly in hillside seeps and in drainageways. They contain some lenses of sandy material

in the substratum. In a few places they are on benches and first bottoms. Most slopes are 2 percent, but they range from 1 to 4 percent. Native vegetation was sedges and grasses and other water-tolerant plants.

In a representative profile of Muck, moderately deep, the surface layer is black to very dark-brown muck and peaty muck 37 inches thick. This is underlain by mottled, greenish-gray and olive silt loam in the upper part and gray, stratified silt loam and loamy sand in the lower part.

Muck soils have high to very high available water capacity. Permeability ranges from moderately rapid to moderate in the organic part, and it is slow in the underlying mineral part. Muck is low in available phosphorus and very low in available potassium. The content of organic matter is very high. Reaction is slightly acid to mildly alkaline. The surface is hummocky unless the soil has been leveled. In undrained areas the water table is at a depth of 0 to 36 inches, depending on the season. In drained areas the water table is generally at the depth of the tile or the open ditch, but it may be higher at times. Muck soils are not suited to row crops unless they are drained.

Representative profile of Muck, moderately deep, 390 feet west of the southeast corner of sec. 21, T. 998 N., R. 12 W., in a cultivated field on an east-facing slope of 1 percent:

Ap—0 to 9 inches, black (10YR 2/1) sapric; massive; very friable; neutral; clear, smooth boundary.

2—9 to 19 inches, black (N 2/0) sapric that has common dark-brown (10YR 3/3) fibers that rub out with difficulty; massive; very friable; neutral; clear, smooth boundary.

3—19 to 26 inches, black (N 2/0) sapric that has common very dark-brown (10YR 2/2) fibers that disintegrate when rubbed; massive; very friable; increase in mineral material; neutral; clear, smooth boundary.

4—26 to 37 inches, black (N 2/0) sapric that has a few fibers that disintegrate when rubbed; massive; friable; mildly alkaline; clear, smooth boundary.

II5—37 to 42 inches, black (N 2/0) silt loam that has a few dark-brown (10YR 3/3) fibers that disintegrate when rubbed; massive; friable; mildly alkaline; clear, smooth boundary.

II6—42 to 54 inches, greenish-gray (5GY 5/1) silt loam that has a few yellowish-brown (10YR 5/4) fibers that disintegrate when rubbed; many, medium, distinct, olive (5Y 4/4) mottles; massive; friable; few, small, soft, yellowish-red (5YR 4/6) oxides; mildly alkaline; clear, smooth boundary.

II7—54 to 64 inches, gray (5Y 5/1) silt loam that has thin, loamy, coarse lenses of sand; massive; friable; mildly alkaline.

The upper organic horizons are typically muck, and the lower ones are muck and peaty muck that in places include lenses of mucky silt loam. The underlying mineral layers are stratified and have variable properties. Within a horizontal distance of a few feet, the texture ranges from silty clay loam to loam, sandy loam, and sand. In upland areas, firm glacial till is below a depth of 40 to 90 inches. On stream benches, below a depth of about 40 to 60 inches, the substratum is stratified loamy sand and gravel.

Muck commonly is associated with the Clyde and Marshan soils. It differs mainly from the Clyde and Marshan soils in that its upper layers consist of organic material rather than mineral material.

Muck, deep (1 to 4 percent slopes) (621).—This soil has a profile similar to the one described as representative for the series, except that it has organic layers that are 40 to 60 inches thick. It is in broad, upland drainageways and on the lower part of hillside seeps. The areas on hillsides are generally 2 to 5 acres in size, and those in drainageways are as much as 15 acres in size. An area about 50 acres in size is 1 mile north of Cresco. This soil is hummocky unless it has been leveled. In a few areas shattered limestone or a shaly material is at a depth of 5 to 8 feet.

This soil is too wet for cultivated crops, and adequate drainage is difficult to establish. If it is properly drained, however, this soil is moderately well suited to row crops. In undrained areas the water table is at or near the surface much of the year. (Capability unit IIIw–2; woodland suitability group 11)

Muck, moderately deep (1 to 4 percent slopes) (221).—This soil has the profile described as representative for the series. It is on the lower part of hillside seeps and in broad upland drainageways. On the hillsides the areas are generally 2 to 4 acres in size, and in the drainageways they are as much as 15 acres in size. Except in areas that have been leveled, this soil is hummocky.

This soil is too wet for cultivated crops, and adequate drainage is difficult to establish. If it is properly drained, however, this soil is moderately well suited to row crops. In undrained areas the water table is at or near the surface during much of the year. (Capability unit IIIw–2; woodland suitability group 11)

Muck, shallow (1 to 4 percent slopes) (21).—This soil has a profile similar to the one described as representative for the series, except that the black organic layers are 10 to 20 inches thick. This soil is commonly on the lower part of hillsides in small seeps 2 to 4 acres in size. It is also in some of the broad upland drainageways. Except in areas that have been leveled, this soil is hummocky.

This soil is too wet for crops, and adequate drainage is difficult to establish. If it is properly drained, however, this soil is moderately well suited to row crops. In undrained areas the water table is at or near the surface during much of the year. (Capability unit IIIw–2; woodland suitability group 11)

Oran Series

The Oran series consists of moderately dark colored, somewhat poorly drained, nearly level to gently sloping soils on uplands. These soils formed in 14 to 24 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones is at the contact surface of the overburden and the glacial till. These soils are on broad ridge crests and the long, slightly convex sides of ridges. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is brown, friable loam 6 inches thick. The subsoil is mottled brown, grayish-brown, and yellowish-brown loam that extends to a depth of 52 inches. The substratum is mottled yellowish-brown and gray, firm loam.

Permeability is moderate in the upper part of these soils and moderately slow in the lower part. These soils have high available water capacity. They are very low in available phosphorus and potassium. The organic-matter content is moderate. Reaction is acid, and the soils need lime unless they have been limed within the past 5 years. Water moves more rapidly in the overburden

than in the glacial till. This causes it to accumulate at the contact surface of these two materials and results in a seasonally perched water table.

Representative profile of Oran loam, 0 to 2 percent slopes, 86 feet east and 154 feet south of the northwest corner of SW¼ sec. 6, T. 98 N., R. 14 W., in a soybean field on a straight slope of 1 percent that faces east:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; grayish brown (10YR 5/2) when dry; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—7 to 13 inches, brown (10YR 5/3) loam; very pale brown (10YR 7/3) grainy coatings when dry; weak, medium, platy structure; friable; very strongly acid; clear, wavy boundary.

B1—13 to 17 inches, brown (10YR 5/3) loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) ped coatings; pale brown (10YR 6/3) and very pale brown (10YR 8/3) silt and sand coatings when dry; moderate, fine and very fine, subangular blocky structure; friable; very few small pebbles; pebble band in lower fringe; very strongly acid; clear, smooth boundary.

IIB21—17 to 23 inches, mottled grayish-brown (2.5Y 5/2) and brown (7.5YR 4/4) heavy loam; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; firm; few, fine, soft, yellowish-red (5YR 4/8) oxides; few small pebbles; very strongly acid; gradual, smooth boundary.

IIB22t—23 to 32 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) heavy loam; nearly continuous light brownish-gray (2.5Y 6/2) prism coatings; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; firm; few patchy clay films on ped faces; common, fine, firm, black (5YR 2/1) oxides and few, fine, soft, yellowish-red (5YR 4/6) oxides; few small pebbles; very strongly acid; gradual, smooth boundary.

IIB23t—32 to 43 inches, mottled yellowish-brown (10YR 5/6) and light-gray (10YR 6/1) heavy loam; nearly continuous light-gray (10YR 6/1) prism coatings of very fine sand and discontinuous grayish-brown (2.5Y 5/2) ped coatings; moderate, medium, prismatic structure parting to weak, coarse, subangular blocky; firm; few, very dark gray (10YR 3/1), patchy clay films on prism and ped faces and in root channels; common, fine, firm, black (10YR 2/1) oxides; few small pebbles; very strongly acid; clear, wavy boundary.

IIB3—43 to 52 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, prominent, light-gray (10YR 6/1) mottles; nearly continuous grayish-brown (2.5Y 5/2) prism coatings; moderate, coarse, prismatic structure; firm; many, fine, hard, black (5YR 2/1) oxides; few small pebbles; strongly acid; gradual, smooth boundary.

IIC—52 to 66 inches, mottled yellowish-brown (10YR 5/6) and gray to light-gray (10YR 6/1) heavy loam; massive, some vertical cleavage; firm; medium acid.

The A1 horizon ranges from black (10YR 2/1) or very dark gray (10YR 3/1) to very dark brown (10YR 2/2) where it is not cultivated, and it is 6 to 9 inches thick. Texture ranges from loam to silt loam that contains enough sand to feel gritty, or light clay loam. The A2 horizon ranges from brown (10YR 5/3) to grayish-brown (10YR 5/2) loam to silt loam and is 4 to 8 inches thick. Depth to the IIB horizon ranges from 14 to 24 inches. The IIB2 horizon ranges from firm loam to firm clay loam. The IIC horizon ranges from loam to light clay loam. Depth to carbonates ranges from 40 to 80 inches. Reaction is strongly acid to very strongly acid in the most acid horizon.

Oran soils formed in material similar to the parent material of Readlyn, Pinicon, and Riceville soils. They have a dark-colored A horizon that is thicker than that of Pinicon soils, but they have a dark-colored A horizon that is thinner than that of Readlyn soils. Oran soils are more friable and contain less clay in the IIB2 horizon than Riceville soils.

Oran loam, 0 to 2 percent slopes (471A).—This soil has the profile described as representative for the series. In most places it is on broad ridges or high upland flats. It is associated with the Bassett, Schley, and Readlyn soils. Most areas are 2 to about 10 acres in size.

This soil is well suited to row crops. The major management concern is wetness in some years, and the major need is to maintain fertility. Tile drainage is beneficial in some years. (Capability unit I–2; woodland suitability group 8)

Oran loam, 2 to 5 percent slopes (471B).—This soil is mostly on long, convex and straight side slopes and on broad, rounded ridge crests. In a few places it is concave and is on the lower part of side slopes and in coves. It is associated with the Bassett, Schley, and Clyde soils. Most areas range from 3 to 50 acres in size. In a few places downslope or near a waterway, the subsoil is stratified and not so acid as on stable ridgetops.

This soil is well suited to row crops. It is subject to slight erosion if cultivated. Providing adequate drainage and controlling erosion at the same time are difficult, because the two measures conflict to some extent. Where this soil is on long, uniform upland slopes, it is well suited to contouring and terracing. These practices slow the movement of surface water and let more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of tiling and terracing helps to alleviate this difficulty. (Capability unit IIe–3; woodland suitability group 8)

Ostrander Series

The Ostrander series consists of dark-colored, well-drained soils on long ridge crests and the sides of ridges on uplands. These soils are nearly level to gently sloping on the ridge crests and gently sloping to moderately sloping on the sides of ridges. These soils formed in 13 to 30 inches of loamy material and the underlying friable glacial till or the loamy sediment derived from glacial till. In many places a layer of pebbles and stones is at the contact surface of the loamy overburden and the underlying material. The loamy overburden is 13 to 22 inches thick on the higher positions and 20 to 30 inches thick on the lower side slopes. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and dark brown loam 12 inches thick. The subsoil, which extends to a depth of 47 inches, is brown to yellowish-brown, friable loam, sandy clay loam, and sandy loam. The substratum is yellowish-brown and strong-brown loam that has a few grayish mottles.

Ostrander soils have high available water capacity and are moderately permeable. They are very low in available phosphorus and potassium. These soils range from medium acid to very strongly acid, and they need lime unless they have been limed within the past 5 years. They are well suited to row crops.

Representative profile of Ostrander loam, 2 to 5 percent slopes 1,000 feet north and 200 feet west of the south-

east corner of sec. 27, T. 98 N., R. 14 W., in a cultivated field on a convex, east-facing slope of 3 percent:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; moderate, fine, granular structure; friable; medium acid; abrupt, smooth boundary.

A3—7 to 12 inches, dark-brown (10YR 3/3) heavy loam; very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) ped coatings; weak, fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

B1—12 to 18 inches, brown (10YR 4/3) heavy loam; nearly continuous dark-brown (10YR 3/3) ped coatings; weak, fine, subangular blocky structure; medium acid; gradual, smooth boundary.

B21—18 to 23 inches, dark yellowish-brown (10YR 4/4) medium loam; brown (10YR 4/3) ped coatings; weak, fine, subangular blocky structure; friable; more sand than in the B1 horizon; medium acid; clear, smooth boundary.

IIB22—23 to 36 inches, yellowish-brown (10YR 5/8) heavy sandy loam; yellowish-brown (10YR 5/4) ped coatings; weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky; friable; few small pebbles; medium acid; clear, wavy boundary.

IIB3—36 to 47 inches, yellowish-brown (10YR 5/6) light sandy clay loam; weak, medium, prismatic structure parting to very weak, coarse, subangular blocky; firm; few yellowish-brown (10YR 5/4) clay films on prism faces; few, very fine, soft, strong-brown (7.5YR 5/6) oxides and coatings on ped faces and a few that are fine, firm, and dark reddish-brown (5YR 2/2); slightly acid; gradual, smooth boundary.

IIC—47 to 74 inches, yellowish-brown (10YR 5/4) and strong-brown (7.5YR 5/6) loam; few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; massive; firm; few, fine, firm, dark reddish-brown (5YR 2/2) oxides; neutral.

The A horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) and is from 12 to 20 inches thick where it is not eroded. Texture ranges from loam to silt loam. The B horizon ranges from friable heavy sandy loam or loam to sandy clay loam and light clay loam. Grayish mottles are present below a depth of 3 feet in places. Depth to carbonates ranges from more than 4 feet to as much as 8 feet. The most acid part ranges from medium acid to very strongly acid.

Ostrander soils formed in material similar to the parent material of Racine and Kenyon soils. They have a dark-colored A horizon that is thicker than that of the Racine soils. Ostrander soils have a more friable IIB horizon than Kenyon soils and, in contrast to Kenyon soils, are free of grayish mottles in the upper part of the IIB horizon.

Ostrander loam, 0 to 2 percent slopes (394A).—This soil is at high positions in the landscape and on low, somewhat benchlike positions. In most places it is associated with soils that are underlain by limestone or sand and gravel. The areas range from 2 acres to about 40 acres in size but are mostly 3 acres to about 7 acres.

This soil is well suited to row crops. Except for maintaining fertility, it has no major management needs. This soil is commonly used for intensive row cropping. The organic-matter content is high. (Capability unit I–2; woodland suitability group 6)

Ostrander loam, 2 to 5 percent slopes (394B).—This soil has the profile described as representative for the series. It is on long, convex ridges and side slopes. In most places it is in downslope positions above Floyd or Schley soils. The areas range from about 2 to 30 acres in size but are generally 4 to 10 acres.

Included in mapping in places are small spots of eroded soils that have a dark-brown surface layer. Also included are a few spots of sandy soils that are shown on the soil map by a special symbol.

This soil is well suited to row crops. If cultivated, it is subject to slight erosion. The organic-matter content is high. (Capability unit IIe–1; woodland suitability group 6)

Ostrander loam, 5 to 9 percent slopes (394C).—This soil has rather short, convex slopes and is on the sides of ridges below areas of the gently sloping Ostrander soils. Most areas are near the larger streams, and they range from 2 acres to about 5 acres in size.

Included in mapping in places are small spots of eroded soils that have a brown and dark-brown surface layer and a few spots of sandy soils that are shown on the soil map by a special symbol. Also included are soils in downslope positions that have silty strata and sandy strata at a depth below 3 or 4 feet.

This soil is well suited to row crops. If cultivated, it is subject to moderate to severe erosion. The organic-matter content in this soil is high. (Capability unit IIIe–1; woodland suitability group 6)

Ostrander loam, 5 to 9 percent slopes, moderately eroded (394C2).—This soil has a profile similar to the one described as representative for the series, except that it has a mixed very dark grayish-brown and dark-brown plow layer that contains some of the subsoil. This soil has rather short, convex slopes and is below areas of the gently sloping Ostrander soils. Most of the acreage is near the larger streams. The areas range from 2 acres to about 4 acres in size. This eroded soil has a lower content of potassium and organic matter than the other Ostrander soils.

Included in mapping in some places are small areas of severely eroded soils that have a yellowish-brown surface layer. Also included are a few spots of sandy soils. These are shown on the soil map by a special symbol.

This soil is well suited to row crops. If cultivated it is subject to severe erosion. The organic-matter content in this soil is moderate. (Capability unit IIIe–1; woodland suitability group 6)

Pinicon Series

The Pinicon series consists of light-colored, somewhat poorly drained soils on uplands. These soils are nearly level on the broad ridge crests and gently sloping on the long, slightly convex side slopes. They formed in 14 to 24 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones is at the contact surface of the overburden and the glacial till. Native vegetation was trees.

In a representative profile the surface layer is very dark gray silt loam 3 inches thick. The subsurface layer is grayish-brown and brown silt loam 8 inches thick. The subsoil, which extends to a depth of 57 inches, is mottled grayish-brown, strong-brown, gray, and yellowish-brown loam and clay loam. The substratum is mottled yellowish-brown and gray loam that is mildly alkaline.

Pinicon soils have high available water capacity. Permeability is moderate in the upper part and moderately slow in the lower part. The soils are low in available phosphorus and potassium. The content of organic matter is low. Reaction is acid, and the soils need lime if none

has been applied within the past 5 years. Water moves more rapidly in the overburden than in the glacial till and accumulates at the contact surface of these two materials. This causes wet, seepy spots in some years.

If cleared of trees and properly managed, these soils are suited to row crops. Providing adequate drainage and controlling erosion at the same time are difficult, because the two measures conflict to some extent. The soils on long, uniform, upland slopes are well suited to contouring and terracing. These practices slow the movement of water and let more of it soak into the soil. This condition complicates drainage, especially in wet years. A combination of tiling and terracing helps alleviate this difficulty.

Representative profile of Pinicon silt loam, 1 to 4 percent slopes, 1,140 feet south and 784 feet east of the northwest corner of SW¼ sec. 19, T. 99 N., R. 14 W., in timbered area on an east-facing slope of 1 percent:

O2—½ inch to 0, partially decomposed fibrous roots.

A1—0 to 3 inches, very dark gray (10YR 3/1) light silt loam, very dark brown (10YR 2/2) when kneaded, gray to light gray (10YR 6/1) when dry; moderate, fine and very fine, granular structure; friable; medium acid; clear, smooth boundary.

A21—3 to 7 inches, grayish-brown (10YR 5/2) light silt loam, light gray (10YR 7/2) when dry; common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, thin, platy structure; friable; strongly acid; clear, smooth boundary.

A22—7 to 11 inches, brown (10YR 5/3) light silt loam; grayish-brown (10YR 5/2) ped coatings; very pale brown (10YR 7/3) when dry; common, fine, faint, brown to dark-brown (10YR 4/3) mottles; moderate, fine, platy structure; friable; very few, fine, hard, dark reddish-brown (5YR 2/2) oxides; strongly acid; clear, smooth boundary.

B1—11 to 17 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (10YR 5/2) heavy loam; dark grayish-brown (10YR 4/2) ped coatings; weak, medium, subangular blocky structure parting to moderate, very fine, subangular blocky; friable; nearly continuous, light gray (10YR 7/1), silt and sand coatings when dry; few, fine, soft, yellowish-red (5YR 5/8) oxides; very strongly acid; clear, smooth boundary.

IIB21t—17 to 25 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/8) heavy loam; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; firm; common, light-gray (10YR 7/2), silt and sand coatings when dry; thin, discontinuous, dark grayish-brown (2.5Y 4/2) clay films in a few root channels and pores; few, fine, soft, yellowish-red (5YR 5/8) oxides; band of pebbles and stones ½ inch to 5 inches in diameter at horizon surface; few small pebbles throughout; very strongly acid; gradual, smooth boundary.

IIB22t—25 to 35 inches, strong-brown (7.5YR 5/6) light clay loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; nearly continuous grayish-brown (2.5Y 5/2) ped coatings; moderate, coarse, prismatic structure parting to weak, medium, subangular blocky; firm; many light-gray (10YR 7/2) silt and sand coatings when dry; few patchy clay films on prism and ped faces; few, fine, dark-red (2.5YR 3/6) and dark reddish-brown (5YR 2/2) oxides and few dark reddish-brown (5YR 2/2) stains on ped faces; few small pebbles; very strongly acid; gradual, smooth boundary.

IIB23t—35 to 44 inches, strong-brown (7.5YR 5/8) light clay loam; common, fine, prominent, gray (5Y 5/1) mottles; prism coatings are grayish brown (2.5Y 5/2) and have thick, discontinuous, dark-gray (10YR 4/1) clay films; very few, discontinuous, grayish-brown (2.5Y 5/2), silt and sand coatings when dry; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; firm; few dark reddish-brown (5YR 2/2) oxides and a few dark reddish-brown (5YR 2/2) stains on ped faces that increase with depth; few small pebbles; medium acid; gradual, smooth boundary.

IIB31—44 to 49 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 5/1) heavy loam; weak, coarse, prismatic structure parting to very weak, coarse, subangular blocky; firm; few dark-gray (10YR 4/1) clay accumulations in root channels and pores; few dark reddish-brown (5YR 2/2) oxides and ped stains; few small pebbles; slightly acid; gradual, smooth boundary.

IIB32—49 to 57 inches, mottled yellowish-brown (10YR 5/6) and gray (5Y 5/1) heavy loam; very weak, coarse, prismatic structure; firm; very few dark-gray (10YR 4/1) clay accumulations in root channels and pores; few dark reddish-brown (5YR 2/2) oxides and stains; few small pebbles; neutral; clear, wavy boundary.

IIC—57 to 68 inches, mottled yellowish-brown (10YR 5/6) and gray (5Y 5/1) heavy loam; massive; firm; few, white (10YR 8/1), mycelia lime accumulations; few, pebbles; strongly effervescent, mildly alkaline.

The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) and is 1 to 4 inches thick in areas that are not cultivated. Texture ranges from loam to silt loam. In cultivated areas the Ap horizon is typically dark gray (10YR 4/1) or dark grayish brown (10YR 4/2). The A2 horizon ranges from 4 to 10 inches in thickness and is generally gritty silt loam but ranges to loam. In cultivated areas the A2 horizon in places is wholly incorporated in the plow layer. The B horizon ranges in texture from loam to light clay loam. Depth to the IIB horizon ranges from 14 to 24 inches. Depth to carbonates ranges from 40 to 80 inches. Reaction is medium acid to very strongly acid in the most acid horizon.

Pinicon soils formed in material similar to the parent material of the Oran soils. They have a dark-colored A horizon that is thinner than that of Oran soils.

Pinicon silt loam, 1 to 4 percent slopes (303B).—Most of this soil is in tracts of timber and has a very dark gray to black surface layer 1 to 4 inches thick. In cultivated areas the plow layer is dark gray to dark grayish brown. This soil is nearly level on broad ridge crests and gently sloping on the long, slightly convex sides of ridges. In a few places on side slopes and in coves, this soil is concave. It is associated with the Coggon, Oran, and Schley soils. Much of the acreage is within a few miles of Lake Hendricks in the northwestern part of the county. Most areas are 3 to 15 acres in size, but one area in section 18 of Jamestown Township is about 90 acres in size.

This soil is well suited to row crops. Although it can be farmed without tile drainage, production increases and fieldwork can be done earlier if drainage is improved. Because permeability is more rapid in the loamy overburden than in the underlying glacial till at a depth of about 1½ feet, water accumulates at the contact surface of these two materials and produces a temporary high water table, particularly early in spring. A combination of terracing and tile drainage is needed in places to provide adequate drainage and at the same time to control erosion. (Capability unit IIw-2; woodland suitability group 8)

Port Byron Series

The Port Byron series consists of dark-colored, well-drained soils on ridges and the sides of ridges where slopes are 2 to 9 percent. These soils formed in thick deposits of loess, generally at the higher elevations on the

generally rolling landscape in the northeastern corner of the county. Native vegetation was prairie grasses. Port Byron soils are closely associated with the Downs soils.

In a representative profile the surface layer is very dark brown and very dark grayish-brown silt loam 18 inches thick. The subsoil is dark yellowish-brown, friable silt loam that extends to a depth of nearly 4 feet. The substratum is mottled, yellowish-brown silt loam and has faint, pale-brown mottles.

Port Byron soils are moderately permeable and have high available water capacity. They are low in available phosphorus and very low in available potassium. The content of organic matter is high. Reaction is acid and lime is needed unless the soil has been limed within the past 5 years. Most of the acreage is cropland.

The main management needs are maintaining fertility and controlling erosion. These soils that have long slopes and are on uplands are well suited to contour cultivation and terracing. In some places alinement of terraces can be greatly improved by cuts and fills and changes in terrace gradient. The subsoil that is exposed by terracing generally responds to treatment more readily than the subsoil of many of the other soils of the county.

Representative profile of Port Byron silt loam, 2 to 5 percent slopes, 475 feet west and 150 feet south of northeast corner of SW¼SE¼ sec. 17, T. 100 N., R. 11 W., in a cultivated field on a slightly convex, north-facing slope of 3 percent:

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam; weak, very fine, granular structure; friable; neutral; abrupt, smooth boundary.

A12—7 to 10 inches, very dark brown (10YR 2/2) silt loam; moderate, fine and very fine, granular structure; friable; neutral; clear, smooth boundary.

A13—10 to 14 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; nearly continuous very dark brown (10YR 2/2) ped coatings; moderate, fine, granular structure; friable; neutral; clear, wavy boundary.

A3—14 to 18 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; discontinuous very dark brown (10YR 2/2) ped coatings; moderate, fine, subangular blocky structure parting to moderate, fine, granular; friable; neutral; clear, wavy boundary.

B21t—18 to 32 inches, dark yellowish-brown (10YR 4/4) heavy silt loam; nearly continuous brown (10YR 4/3) prism and ped coatings; weak, fine, prismatic structure parting to moderate, medium and fine, subangular blocky; friable; few, dark brown (10YR 3/3), patchy clay films on prism faces and on both vertical and horizontal ped faces; few gray silt coatings on prism faces; strongly acid; gradual, smooth boundary.

B22t—32 to 39 inches, dark yellowish-brown (10YR 4/4) silt loam; nearly continuous brown (10YR 4/3) prism and ped coatings; weak, fine, prismatic structure parting to weak, medium, subangular blocky; friable; very few, dark yellowish-brown (10YR 3/4), patchy clay films and few gray silt coatings on prism faces; medium acid; gradual, smooth boundary.

B3—39 to 47 inches, dark yellowish-brown (10YR 4/4) silt loam; few, fine, faint, pale-brown (10YR 6/3) mottles and strong-brown (7.5YR 5/6) mottles; weak, fine, prismatic structure; friable; few gray silt coatings on prism faces; medium acid; gradual, smooth boundary.

C1—47 to 55 inches, mottled, yellowish-brown (10YR 5/4) silt loam; few, fine, faint, pale-brown (10YR 6/3) mottles; massive; friable; few strong-brown (7.5YR 5/8) stains; medium acid; clear, wavy boundary.

C2—55 to 72 inches, yellowish-brown (10YR 5/4) silt loam; massive; friable; common, fine, faint, pale-brown (10YR 6/3) mottles in upper 6 inches; few strong-brown (7.5YR 5/8) stains; slightly acid.

The A1 horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and is 10 to 18 inches thick in areas that are not eroded. The B horizon ranges from dark brown (10YR 3/3) or dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/4). It is typically silt loam but ranges to light silty clay loam that is less than 29 percent clay. A few grayish mottles are present in places at a depth below 36 inches. Calcareous material is at a depth below 5 or 6 feet. Reaction is medium acid to strongly acid in the most acid horizon.

The Port Byron soils formed in materials similar to the parent material of the Downs and Fayette soils. They have a dark-colored A horizon that is thicker than that of Downs or Fayette soils.

Port Byron silt loam, 2 to 5 percent slopes (620B).—This soil is on rather broad ridge crests and the sides of ridges. It also occupies some of the saddles between more sloping soils. It is associated with Downs soils. Most areas are about 3 to 15 acres in size. In a few places the surface layer is only about 7 inches thick.

Included in mapping are areas of soils, adjacent to some of the waterways, that have a very dark brown surface layer 20 to 24 inches thick. Also included in a few places are soils that have limestone bedrock within 30 to 50 inches of the surface.

This soil is well suited to row crops. If cultivated, it is subject to slight erosion. It is well suited to contouring and terracing. (Capability unit IIe-1; woodland suitability group 4)

Protivin Series

The Protivin series consists of dark-colored, somewhat poorly drained soils on uplands. These soils are nearly level on broad ridges and gently sloping on the long, slightly convex sides of ridges. These soils formed in 14 to 24 inches of loamy material and the underlying very firm clay loam glacial till. In most places a layer of pebbles and stones is at the contact surface of the overburden and the glacial till. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark gray loam 15 inches thick. The upper part of the subsoil extends to a depth of 23 inches and is mottled dark grayish-brown and olive-brown, friable loam. The lower part of the subsoil extends to a depth of 45 inches and is mottled gray, strong-brown, and yellowish-brown, very firm clay loam that has gray coatings on the structure faces. The substratum is mottled gray, strong-brown, and yellowish-brown, very firm clay loam that is mildly alkaline.

Protivin soils have high available water capacity. They are moderately permeable to a depth of 1 or 2 feet and slowly permeable below that depth. Water moves through the loamy overburden more rapidly than through the glacial till. This causes water to accumulate at their contact surface and results in a seasonal perched water table. Available phosphorus and potassium are very low, and organic-matter content is high. These soils are acid in reaction and need lime if they have not been limed within the past 5 years.

Representative profile of Protivin loam, 1 to 4 percent slopes, 380 feet west and 63 feet south of the northeast corner of NW¼NE¼, sec. 9, T. 99 N., R. 13 W., in a cultivated field on a west-facing slope of 1 percent:

Ap—0 to 8 inches, black (10YR 2/1) heavy loam; weak, fine, granular structure; friable; strongly acid; clear, smooth boundary.

A12—8 to 11 inches, black (10YR 2/1) heavy loam; moderate, fine, granular structure; friable; strongly acid; gradual, smooth boundary.

A3—11 to 15 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) heavy loam; weak, medium, subangular blocky structure; friable; strongly acid; gradual, smooth boundary.

B11—15 to 19 inches, dark grayish-brown (2.5Y 4/2) heavy loam; common, fine, faint, yellowish-brown (10YR 5/4) mottles; few very dark gray (10YR 3/1) ped coatings; weak, fine to very fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B12—19 to 23 inches, olive-brown (2.5Y 4/4) and dark grayish-brown (2.5Y 4/2) heavy loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; band of pebbles ¼ inch to 1½ inches in diameter in lower part of horizon; medium acid; clear, smooth boundary.

IIB21t—23 to 34 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 5/1) clay loam; nearly continuous gray (5Y 5/1) prism and ped coatings; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; very firm; few, thin, discontinuous, very dark gray (N 3/0) clay films on prism and ped faces and in pores and root channels; few small pebbles; slightly acid; gradual, smooth boundary.

IIB22t—34 to 40 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 5/1) clay loam; discontinuous gray (5Y 5/1) prism and ped coatings; moderate, medium, prismatic structure parting to weak, medium, subangular blocky; very firm; very few very dark gray (10YR 3/1) clay films on prism faces and in pores and root channels; neutral; gradual, smooth boundary.

IIB3t—40 to 45 inches, mottled gray (5Y 5/1), yellowish-brown (10YR 5/6), and strong-brown (7.5Y 5/6) clay loam; weak, medium, prismatic structure parting to very weak, medium, subangular blocky; very firm; very few streaks of very dark gray clay films on prism faces; neutral; clear, wavy boundary.

IIC—45 to 60 inches, mottled gray (10YR 5/1), yellowish-brown (10YR 5/6), and strong-brown (7.5YR 5/6) light clay loam; massive; very firm; very few, prominent, reddish-brown (5YR 4/4) oxide concretions; some vertical cleavage faces in upper part; strongly effervescent, mildly alkaline.

The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) in color and from 10 to 16 inches in thickness. Texture is generally loam but ranges to silt loam and light clay loam that contains enough sand to feel gritty. Depth to the IIB horizon ranges from 14 to 24 inches. The IIB2t horizon ranges from light clay loam to medium clay loam and is 28 to 35 percent clay. The C horizon is clay loam to heavy loam. Depth to carbonates ranges from 40 to 60 inches. The A horizon below the plow layer and the upper part of the B horizon range from medium acid to very strongly acid. The lower part, which is the IIB horizon, ranges from medium acid to neutral or mildly alkaline.

Protivin soils formed in material similar to the parent material of Riceville, Readlyn, and Jameston soils. They have a dark-colored A horizon that is thicker than that of Riceville soils. They contain more clay and have a firmer consistence in the IIB horizon than Readlyn soils. Protivin soils are not so poorly drained as Jameston soils.

Protivin loam, 1 to 4 percent slopes (798B).—This soil is on the long, convex sides and the broad, rounded crests of ridges. In a few places it is concave on downslopes and in coves. This soil is associated with Cresco and Riceville soils. Generally it is below Cresco soils and above Jameston or Clyde soils. In places it is above Floyd soils. Areas range from 3 to about 60 acres in size in most places.

Included in mapping are a few spots of soils that have a thinner and lighter colored surface layer and a few small areas of soils that have thin strata of sandy material.

This soil is well suited to row crops if it is properly drained. Because of the slowly permeable subsoil, wetness and seepage are concerns in wet periods. Tile drainage is beneficial during these periods. Spacing and placement of tile lines are important. A drainage system that is designed to intercept the water that moves laterally is the most effective means of draining these slowly permeable soils. The more sloping soils in cultivated areas are subject to slight erosion. A combination of terracing and tile drainage may be needed to provide adequate erosion control and drainage. (Capability unit IIw-3; woodland suitability group 7)

Racine Series

The Racine series consists of moderately dark colored, well-drained soils on uplands. These soils are nearly level to gently sloping on long ridge crests and gently sloping to moderately sloping on the sides of ridges. They formed in 13 to 30 inches of loamy material and the underlying friable glacial till or the loamy sediment that is derived from glacial till. In many places a layer of pebbles and stones is at the contact surface of the loamy overburden and the underlying material. The loamy overburden is 13 to 22 inches thick in the higher parts of the landscape and 20 to 30 inches thick in the lower parts. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam 7 inches thick. The subsurface layer is brown and dark yellowish-brown, friable loam 3 inches thick. The subsoil, which extends to a depth of 47 inches, is yellowish brown in the upper part and yellowish brown and strong brown in the lower part. Its texture is loam and sandy clay loam. The substratum is yellowish-brown sandy clay loam mottled with grayish brown.

Racine soils have high available water capacity and moderate permeability. They are low in available phosphorus and very low in available potassium. These soils are acid in reaction and need lime unless they have been limed within the past 5 years.

Representative profile of Racine loam, 2 to 5 percent slopes, 1,180 feet north and 811 feet east of the southwest corner of sec. 10, T. 98 N., R. 11 W., in a cornfield on a convex, southwest-facing slope of 3 percent:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; few roots; medium acid; clear, smooth boundary.

A2—7 to 10 inches, brown (10YR 4/3) and dark yellowish-brown (10YR 3/4) loam; nearly continuous very dark grayish-brown (10YR 3/2) ped coatings and pale-brown (10YR 6/3) silt and sand coatings when dry; weak, coarse, platy structure parting to weak, fine, subangular blocky and granular; friable; medium acid; clear, wavy boundary.

B1—10 to 14 inches, dark yellowish-brown (10YR 4/4) loam; brown and dark-brown (10YR 4/3 and 3/3) ped coatings and light-gray (10YR 7/2) grainy coatings when dry; moderate, fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

IIB21t—14 to 30 inches, yellowish-brown (10YR 5/6) loam; few dark yellowish-brown (10YR 4/4) prism and ped coatings in upper few inches of horizon; weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky; friable; few, dark-brown (10YR 3/3 and 7.5YR 3/2), patchy clay films on prism and ped faces; band of pebbles at surface of horizon, few small pebbles throughout; strongly acid; clear, wavy boundary.

IIB22t—30 to 37 inches, strong-brown (7.5YR 5/8) and yellowish-brown (10YR 5/6) light sandy clay loam; discontinuous brown (10YR 5/3) prism and ped coatings; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; very few dark-brown (7.5YR 3/2) patchy clay films on prism and ped faces; few small pebbles; medium acid; gradual, smooth boundary.

IIB3t—37 to 47 inches, strong-brown (7.5YR 5/8) and yellowish-brown (10YR 5/6) light sandy clay loam; few, fine, distinct, grayish-brown (10YR 5/2) mottles; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; friable; very few, patchy, dark yellowish-brown (10YR 4/4) clay films on prism faces; very few, fine, soft, black (10YR 2/1) oxide concretions; few small pebbles; medium acid; gradual, smooth boundary.

IIC—47 to 72 inches, yellowish-brown (10YR 5/6) light sandy clay loam; many, medium, prominent, grayish-brown (10YR 5/2) mottles and few, fine, faint, strong-brown (7.5YR 5/8) mottles; massive; firm; very few, soft, black (10YR 2/1) oxide concretions; neutral.

The Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) in color and from 6 to 9 inches in thickness. Texture ranges from loam to silt loam that contains enough sand to feel gritty. The A2 horizon is 3 to 5 inches thick. Texture ranges from loam to silt loam that contains enough sand to feel gritty. Depth to grayish mottles is 36 inches or more. The B horizon ranges from loam or sandy clay loam to light clay loam that has thin layers of heavy sandy loam. Depth to carbonates ranges from 5 to 8 feet. Reaction is medium acid to very strongly acid in the most acid horizon.

Racine soils formed in material similar to the parent material of Ostrander, Renova, and Bassett soils. They have a dark-colored A horizon that is thinner than that of Ostrander soils, and they have a dark-colored A horizon that is thicker than that of Renova soils. Racine soils have a IIB horizon that is more friable than that of Bassett soils.

Racine loam, 0 to 2 percent slopes (482A).—This soil is in high areas in the landscape and in low, somewhat benchlike areas. In most places it is associated with soils that are underlain by limestone or sand and gravel. The areas range from 2 acres to about 40 acres in size, but most are 3 acres to about 7 acres.

This soil is well suited to row crops. Except for maintaining fertility, there is no major management need. This soil is suited to intensive row cropping. The organic-matter content of this soil is moderate. (Capability unit I–2; woodland suitability group 6)

Racine loam, 2 to 5 percent slopes (482B).—This soil has the profile described as representative for the series. It is on long, convex ridges and the sides of ridges. In most places it is in downslope positions above Floyd and Schley soils. The areas range from about 2 to 30 acres in size but generally are 4 to 10 acres.

Included in mapping in places are small spots of eroded soils that have a brown or dark-brown surface layer. Also included are a few spots of sandy soils. These sandy spots are shown on the soil map by a special symbol. Some included soils in downslope positions have lenses of sandy or silty material between depths of 3 and 4 feet.

This soil is well suited to row crops. It is subject to slight erosion if it is cultivated. The organic-matter content in this soil is moderate. (Capability unit IIe–1; woodland suitability group 6)

Racine loam, 5 to 9 percent slopes (482C).—This soil is on rather short, convex side slopes below areas of the gently sloping Racine soils. Most areas are near the larger streams. They range from about 2 to 5 acres in size.

Included in mapping in places are small spots of eroded soils that have a brown and dark-brown surface layer. Also included are a few spots of sandy soils. These sandy spots are shown on the soil map by a special symbol. The included soils in downslope positions have lenses of sandy or silty material between depths of 3 and 4 feet.

This soil is well suited to row crops. It is subject to moderate to severe erosion if it is cultivated. The organic-matter content is moderate. (Capability unit IIIe–1; woodland suitability group 6)

Racine loam, 5 to 9 percent slopes, moderately eroded (482C2).—This soil has a profile similar to the one described as representative for the series, except that it has a mixed very dark grayish-brown and brown plow layer. This soil is on rather short, convex side slopes below areas of the gently sloping Racine soils. Most areas are near the larger streams. They range from 2 acres to about 4 acres in size.

Included in mapping in places are small spots of severely eroded soils that have a yellowish-brown surface layer. Also included are a few spots of sandy soils that are more droughty. These sandy spots are shown on the soil map by a special symbol. The included soils in downslope positions have silty or sandy strata between depths of 3 and 4 feet.

This soil is well suited to row crops. It is subject to severe erosion if it is cultivated. The content of potassium is lower than in uneroded Racine soils. The organic-matter content is moderately low. (Capability unit IIIe–1; woodland suitability group 6)

Radford Series

The Radford series consists of moderately dark, moderately well drained soils. These soils are nearly level on the flood plains and gently sloping in the narrow upland valleys in the northeastern part of the county. They formed in recent deposits of silty, medium-textured, stratified alluvium. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer, where cultivated, is very dark gray silt loam about 9 inches thick. The substratum begins at a depth of 9 inches and reaches to a depth of 33 inches. It is thinly stratified, very dark gray, dark grayish-brown, and grayish-brown silt loam. A buried soil, which begins at a depth of 33 inches, is black silt loam to a depth of 50 inches and black loam to a depth of 60 inches.

Radford soils are moderately permeable and have high available water capacity. They are medium in available phosphorus and very low in available potassium.

Reaction is generally neutral, and the soil does not require lime. In the narrow upland valleys where water concentrates, these soils are subject to some gully erosion. These soils are also subject to floods of high velocity and short duration.

Representative profile of Radford silt loam, 147 feet west of center of bridge in NE¼NE¼ sec. 23, T. 100 N., R. 11 W., in a pasture on a flat, narrow flood plain:

Ap—0 to 9 inches, very dark gray (10YR 3/1) silt loam; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

C—9 to 33 inches, very thinly stratified, very dark gray (10YR 3/1) (80 percent), dark grayish-brown (10YR 4/2), and grayish-brown (2.5Y 5/2) silt loam, pale brown (10YR 6/3) and grayish brown (10YR 5/2) when dry; few, fine, distinct, dark-brown (7.5Y 4/4) mottles are oriented along the surfaces of strata; massive; friable; few roots; neutral; abrupt, smooth boundary.

IIA11b—33 to 50 inches, black (10YR 2/1) silt loam; moderate, fine and very fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.

IIA12b—50 to 60 inches, black (N 2/0) loam; weak, medium, subangular blocky structure; friable; neutral.

The Ap horizon is silt loam that ranges from black (10YR 2/1) or very dark gray (10YR 3/1) to very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). Thickness ranges from 6 to 10 inches. Texture of the C horizon is generally silt loam but some strata range to loam, fine sandy loam, or loamy fine sand. Color ranges from very dark gray (10YR 3/1) to pale brown (10YR 6/3). The recent, stratified, silty material over the buried soil ranges from 18 to 36 inches in thickness. The IIA horizon, which is a buried soil, ranges from black (10YR 2/1) to very dark gray (10YR 3/1) in color. Its texture ranges from silt loam or loam to light silty clay loam or light clay loam that contains enough sand to feel gritty. Reaction ranges from slightly acid to mildly alkaline in the most acid horizon.

Radford soils formed in material similar to the parent material of the Huntsville soils. They have a dark-colored A horizon that is thinner than that of Huntsville soils and are more stratified.

Radford silt loam (0 to 2 percent slopes) (467).—This soil has the profile described as representative for the series. This soil is nearly level and is on flood plains, in upland valleys, and on alluvial fans at the outlets of upland valleys.

Included in mapping are a few acreas of sandy soils that are more droughty. Also included in a few places are stratified soils of black and dark-brown silt loam. Areas range from 3 to 40 acres in size.

This soil is well suited to row crops if it is protected against flooding. It is subject to floods of high velocity and of short duration. If it does not flood too frequently, this soil is suited to intensive row croping. The organic-matter content in this soil is moderate. (Capability unit I–1; woodland suitability group 9)

Radford and Huntsville silt loams, 2 to 5 percent slopes (195B).—The soils in this undifferentiated group are moderately dark colored and dark colored. The Radford and Huntsville soils in such close association that it is impractical to map them separately. In narrow upland valleys these soils are associated with the Downs, Fayette, and Port Byron soils. The Radford soils occupy the waterways. The Huntsville soils are gently sloping and are on the sides of ridges adjoining the waterways. They have the profile described as representative for the Huntsville series. Areas range from 2 acres to about 4 acres in size.

These soils are well suited to row crops. They are subject to slight sheet erosion and to gully and channel erosion in areas where water concentrates. They can be protected from runoff and siltation if diversions are constructed on the adjacent, higher lying soils. Individual areas of soils are small, and that part of them that is not in a grassed waterway is commonly farmed with the surrounding soils. Organic-matter content is moderate in Radford soils and high in Huntsville soils. (Capability unit IIe–5; woodland suitability group 9)

Readlyn Series

The Readlyn series consist of dark-colored, somewhat poorly drained soils on uplands. These soils are nearly level on the broad ridges and gently sloping on the long, slightly convex side slopes. They formed in 14 to 24 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones is between the loamy overburden and the glacial till. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark brown loam 13 inches thick. The upper part of the subsoil, which extends to a depth of 23 inches, is very dark grayish-brown and olive-brown, friable loam; and the lower part of the subsoil, which reaches a depth of 55 inches, is yellowish-brown, firm loam mottled with gray and grayish brown. The substratum is mottled gray and brownish-yellow, firm loam that is mildly alkaline.

Readlyn soils have high available water capacity. Permeability is moderate in the upper part of these soils and moderately slow in the lower part. Water moves more rapidly in the overburden than in the glacial till and accumulates at the contact surface of the two materials. This causes a seasonal perched water table. These soils are very low in phosphorus and potassium. The organic-matter content is high. These soils are acid in reaction and need lime unless they have been limed within the past 5 years.

Representative profile of Readlyn loam, 0 to 2 percent slopes, 755 feet south and 70 feet east of the northwest corner of sec. 19, T. 100 N., R. 14 W., in a cultivated field on a south-facing slope of 1.5 percent:

Ap—0 to 7 inches, black (10YR 2/1) loam; weak, fine and very fine, granular structure; friable; medium acid; clear, smooth boundary.

A1—7 to 13 inches, very dark brown (10YR 2/2) heavy loam; black (10YR 2/1) ped coatings; moderate, very fine, granular structure; friable; medium acid; gradual, smooth boundary.

B1—13 to 19 inches, very dark grayish-brown (2.5Y 3/2) heavy loam; few, faint, dark grayish-brown (2.5Y 4/2) mottles; discontinuous very dark grayish-brown (10YR 3/2) ped coatings; moderate, fine and very fine, subangular blocky structure; friable; band of pebbles at base of horizon; medium acid; clear, smooth boundary.

IIB21—19 to 23 inches, olive-brown (2.5Y 4/4) heavy loam; few, fine, faint, dark grayish-brown (2.5Y 4/2) mottles; moderate, medium, prismatic structure parting to moderate, fine and very fine, subangular blocky; friable; few small pebbles; slightly acid; gradual smooth boundary.

IIB22—23 to 37 inches, yellowish-brown (10YR 5/6) heavy loam; few, fine, distinct, dark grayish-brown (2.5Y 4/2) mottles; dark grayish-brown (2.5Y 4/2) ped coatings; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; firm;

patchy clay films on prism and vertical ped faces; very few very dark gray (10YR 3/1) clay films in pores and root channels; few, fine, soft, strong-brown oxides; few small pebbles; slightly acid; clear, wavy boundary.

IIB31—37 to 46 inches, yellowish-brown (10YR 5/8) heavy loam; many, fine, distinct, grayish-brown (2.5Y 5/2) mottles; nearly continuous olive-gray (5Y 5/2) prism coatings; moderate, medium, prismatic structure; firm; few, fine, soft, yellowish-red (5Y 4/8) oxides and fine, hard, dark reddish-brown (5YR 2/2) oxides; few small pebbles; neutral; gradual, smooth boundary.

IIB32—46 to 55 inches, mottled gray (5Y 5/1), light olive-brown (2.5Y 5/4), and yellowish-brown (10YR 5/6) heavy loam; very weak, medium, prismatic structure; firm; few, fine, firm, dark reddish-brown (5YR 2/2) oxides; few small pebbles; mildly alkaline; clear, wavy boundary.

IIC—55 to 72 inches, mottled light gray (5Y 6/1), brownish-yellow (10YR 6/8), and yellowish-brown (10YR 5/6) heavy loam; massive; firm; few small lime concretions; few small pebbles; strongly effervescent, mildly alkaline.

The A horizon ranges from black (10YR 2/1) to very dark grayish-brown (2.5Y 3/2) in color and from loam to silty clay loam that contains enough sand to feel gritty in texture. It is 16 to 20 inches thick. Depth to the IIB horizon ranges from 14 to 24 inches. Texture of the IIB horizon ranges from loam to light clay loam or sandy clay loam in the upper part and from heavy loam to light clay loam in the lower part. Reaction ranges from medium acid to very strongly acid in the most acid horizon. Depth to carbonates ranges from 40 to 70 inches.

Readlyn soils formed in material similar to the parent material of Oran, Protivin, and Tripoli soils. They have a dark-colored A horizon that is thicker than that of Oran soils. They contain less clay and are less firm in the IIB horizon than Protivin soils. Readlyn soils are better drained than Tripoli soils.

Readlyn loam, 0 to 2 percent slopes (399A).—This soil has the profile described as representative for the series. In most places it is on broad ridges or high upland flats. It is associated with Kenyon, Floyd, and Oran soils. In most places areas range from 2 to about 10 acres in size. In some places the surface layer is somewhat thinner than is normal.

Included in mapping are some soils that have a subsoil that is free of grayish mottles above a depth of 24 inches.

This soil is well suited to row crops. Major management concerns are wetness in some years and fertility. Tile drainage is beneficial in some years. (Capability unit I–2; woodland suitability group 8)

Readlyn loam, 2 to 5 percent slopes (399B).—This soil has a profile similar to the one described as representative for the series, except that in a few spots the surface layer is thinner and lighter colored. This soil is mostly on long, convex sides of ridges and on broad, rounded crests of ridges. In a few places it is in concave downslope areas and in coves. It is associated with the Kenyon, Floyd, and Clyde soils. Most areas range from 3 acres to about 50 acres in size.

This soil is well suited to row crops. It is subject to slight erosion if it is cultivated. Providing adequate drainage and controlling erosion at the same time is difficult, because the two measures conflict to some extent. The long, uniform upland slopes are well suited to contouring and terracing. These practices slow the movement of surface water and let more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of tiling and terracing helps to alleviate this difficulty. (Capability unit IIe–3; woodland suitability group 8)

Renova Series

The Renova series consists of light-colored, gently sloping, well-drained soils on uplands. These soils are on the long ridge crests and the sides of ridges. They formed in 13 to 30 inches of loamy material and the underlying friable glacial till or the loamy sediment that derived from glacial till. The loamy overburden is 13 to 22 inches thick on the more stable parts of the landscape and 20 to 30 inches thick in downslope positions. The content of sand is slightly higher in the downslope positions. In many places a layer of pebbles and stones is at the contact surface of the overburden and the glacial till. Native vegetation was trees.

In a representative profile the surface layer is thin, very dark gray loam. The subsurface layer is dark grayish-brown loam about 9 inches thick. The subsoil extends to a depth of 80 inches. It is brown, dark yellowish-brown, and yellowish-brown, friable loam and heavy sandy loam in the upper part and yellowish-brown, firm loam that has some mottles in the lower part. The substratum is dark-brown, firm loam.

Renova soils have a high available water capacity and are moderately permeable. They are very low in available phosphorus and potassium. These soils are acid in reaction and need lime if they have not been limed within the past 5 years.

Representative profile of Renova loam, 2 to 5 percent slopes, 800 feet west and 40 feet south of the northeast corner of SE¼ sec. 12, T. 97 N., R. 12 W., in a stand of timber on the crest of a convex slope of 2 percent:

O2—1 inch to 0, very dark brown (10YR 2/2) organic matter composed of partially decomposed leaves, root fibers, and many plant fibers and mixed with a very small quantity of silt and sand grains.

A1—0 to 1 inch, very dark gray (10YR 3/1) light loam, dark gray (10YR 4/1) when dry; moderate, fine and very fine, granular structure; friable; many fine roots; few black (10YR 2/1) worm casts; slightly acid; clear, wavy boundary.

A2—1 to 10 inches, dark grayish-brown (10YR 4/2) light loam, pale brown (10YR 6/3) when dry; light-gray (10YR 7/2) silt and sand ped coatings when dry; moderate, thin, platy structure; friable; very strongly acid; clear, wavy boundary.

B1—10 to 14 inches, brown (10YR 4/3) light loam; light-gray (10YR 7/2) silt and sand coatings when dry; moderate, medium, subangular blocky structure; friable; very strongly acid; clear, smooth boundary.

IIB21—14 to 26 inches, dark yellowish-brown (10YR 4/4) loam; brown (10YR 4/3) prism coatings; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; the prisms and a few peds have nearly continuous white (10YR 8/2) coatings of uncoated quartz grains when dry; few dark-brown clay films on prisms and many dark-brown clay films on peds; clay films are mostly concentrated in one-inch horizontal bands in the upper 4 inches; very strongly acid; clear, wavy boundary.

IIB22t—26 to 40 inches, yellowish-brown (10YR 5/6) heavy sandy loam; dark yellowish-brown (10YR 4/4) prism coatings; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; friable; few, dark-brown (10YR 3/3), patchy clay films; few pebbles; strongly acid; clear, smooth boundary.

IIB23t—40 to 49 inches, yellowish-brown (10YR 5/6) loam; nearly continuous yellowish-brown (10YR 5/4) prism and ped coatings; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; firm; few, patchy, dark-brown (10YR 3/3) clay films on prism and ped faces; few pebbles; very strongly acid; gradual, smooth boundary.

IIB31t—49 to 65 inches, yellowish-brown (10YR 5/6) heavy loam; yellowish-brown (10YR 5/4) prism coatings; few, fine, distinct, yellowish-red (5YR 4/6) mottles; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; firm; few dark-brown (10YR 3/3) clay films on prism and ped faces; few pebbles; very few, small (1 millimeter), black (5YR 2/1) and red (2.5YR 4/8) oxide concretions; strongly acid; gradual, smooth boundary.

IIB32t—65 to 80 inches, yellowish-brown (10YR 5/6) heavy loam; weak, medium, prismatic structure; firm; very few dark yellowish-brown (10YR 3/4) clay films on prism faces; few, small (1 millimeter), black (5YR 2/1) and reddish-brown (5YR 4/4) oxide concretions; few pebbles; strongly acid; gradual boundary.

IIC—80 to 90 inches, mottled dark-brown (7.5YR 4/4) heavy loam; massive; firm; few, soft, reddish-brown (5YR 4/4) oxide concretions; few pebbles; medium acid.

The A1 horizon ranges from very dark gray (10YR 3/1) or very dark brown (10YR 2/2) to dark grayish brown (10YR 4/2) and is less than 5 inches thick in uncultivated areas. The texture ranges from loam to silt loam that contains enough sand to feel gritty. The A2 horizon ranges from loam to silt loam that contains enough sand to feel gritty. It is 6 to 10 inches thick in uncultivated and uneroded areas. In some eroded areas the A2 horizon is wholly incorporated in the Ap horizon. Depth to grayish mottles is more than 34 inches. The B horizon ranges from loam or sandy clay loam in the upper part to light clay loam that has thin strata of sandy loam in the lower part. The C horizon ranges from loam or sandy loam to light loam. Depth to carbonates is 5 to 8 feet. Reaction ranges from medium acid to very strongly acid in the most acid horizon.

Renova soils formed in material similar to the parent material of Racine and Coggon soils. They have a dark-colored A horizon that is thinner than that of Racine soils. Renova soils have a more friable IIB2 horizon than Coggon soils, and they lack the grayish mottles of Coggon soils.

Renova loam, 2 to 5 percent slopes (491B).—This soil is on long, convex ridges and the sides of ridges. In most places it is in slightly downslope positions above the Floyd and Schley soils. Areas are generally 2 to 5 acres in size. Most of the acreage is covered by trees.

Included in mapping in some areas are a few small spots of sandy soils. These are shown on the soil map by a special symbol. In downslope positions are included soils that have lenses of sandy or silty material below a depth of 3 or 4 feet.

This soil is well suited to row crops. It is subject to slight erosion if it is cultivated. The organic-matter content of this soil is low. (Capability unit IIe-1; woodland suitability group 6)

Riceville Series

The Riceville series consists of moderately dark colored, somewhat poorly drained soils on uplands. These soils are nearly level on broad ridges and gently sloping on long, convex sides of ridges. They formed in 14 to 24 inches of loamy material and the underlying very firm clay loam glacial till. In most places a layer of pebbles and stones is at the contact surface of the overburden and the glacial till. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is black loam that is 6 inches thick. The subsurface layer is dark grayish-brown silt loam 3 inches thick. The subsoil extends to a depth of 48 inches. The upper part of the subsoil is mottled, dark grayish-brown and olive-brown loam and clay loam. The lower part of the subsoil is mottled gray and yellowish-brown, very firm clay loam that has gray coatings on the structure faces. The substratum is mottled gray and yellowish-brown, firm clay loam that is mildly alkaline.

Riceville soils have a high available water capacity. Permeability is moderate in the upper 1 or 2 feet of these soils and slow below that depth. Water moves more rapidly in the overburden than in the glacial till and accumulates at the contact surface of the two materials. This causes a seasonal perched water table and sidehill seepage in wet years. These soils are very low in available phorphorus and potassium. Reaction is acid, and the soils need lime unless they have been limed within the past 5 years.

Representative profile of Riceville loam, 1 to 4 percent slopes, 510 feet west and 73 feet south of the northeast corner of sec. 25, T. 99 N., R. 13 W., in a cultivated field on a slightly convex, southeast-facing slope of 2 percent:

Ap—0 to 6 inches, black (10YR 2/1) heavy loam, very dark brown (10YR 2/2) when crushed; moderate; fine, granular structure; friable; strongly acid; abrupt, smooth boundary.

A2—6 to 9 inches, dark grayish-brown (10YR 4/2) silt loam; few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; weak, medium, platy structure parting to weak, fine, subangular blocky; friable; discontinuous very dark grayish-brown (10YR 3/2) ped coatings; very strongly acid; clear, smooth boundary.

B11—9 to 15 inches, olive-brown (2.5Y 4/4) to dark grayish-brown (2.5Y 4/2) loam; common, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; friable; discontinuous dark grayish-brown (2.5Y 4/2) ped coatings; very strongly acid; gradual, smooth boundary.

B12—15 to 20 inches, dark grayish-brown to olive-brown (2.5Y 4/3) light clay loam; dark grayish-brown (2.5Y 4/2) ped coatings; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; friable; band of pebbles at a depth of 20 inches; very strongly acid; clear, smooth boundary.

IIB21t—20 to 27 inches, mottled gray (5Y 5/1) and yellowish-brown (10YR 5/6) clay loam; discontinuous gray (5Y 5/1) ped coatings; moderate, medium, subangular blocky structure; very firm; moderately thick, discontinuous, very dark gray (N 3/0) clay films on prism and ped faces in upper part of horizon and in a few root channels; few small pebbles; strongly acid; clear, wavy boundary.

IIB22t—27 to 42 inches, mottled gray (5Y 5/1) and yellowish-brown (10YR 5/6) clay loam; continuous gray (5Y 5/1) prism and ped coatings; moderate, coarse and medium, prismatic structure parting to moderate, medium, subangular blocky; very firm; moderately thick, discontinuous, very dark gray (N 3/0) clay films on prism and ped faces in upper part of horizon and in a few root channels; few small pebbles; strongly acid; clear, wavy boundary.

IIB3—42 to 48 inches, mottled gray (5Y 5/1) and yellowish-brown light clay loam; continuous gray (5Y 5/1) prism coatings and discontinuous gray (5Y 5/1) ped coatings; moderate, medium, prismatic structure parting to weak, coarse, subangular blocky; very firm; few, black (10YR 2/1), patchy clay films on prism faces and in a few root channels; few small

pebbles; strongly effervescent; mildly alkaline; diffuse, smooth boundary.

IIC—48 to 60 inches, mottled gray (5Y 5/1) and yellowish-brown (10YR 5/8) light clay loam; massive; firm; few small pebbles; strongly effervescent; mildly alkaline.

The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) and is 6 to 9 inches thick in uncultivated areas. It is black (10YR 2/1) to very dark grayish-brown (10YR 3/3) in cultivated areas. The A1 or Ap horizon ranges from loam or silt loam to light silty clay loam that contains enough sand to feel gritty. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3) loam to silt loam and is 3 to 5 inches thick. In some cultivated areas the original subsurface layer is incorporated into the plow layer. Depth to the IIB horizon ranges from 14 to 24 inches. Texture ranges from loam to light clay loam in the B1 horizon and from medium to heavy clay loam in the IIB horizon. The IIB2 horizon ranges from 30 to 35 percent clay, but in some places thin layers within the horizon contain as much as 38 percent clay. Depth to carbonate ranges from 40 to 70 inches. Reaction is strongly acid to very strongly acid in the most acid horizon.

Riceville soils formed in material similar to the parent material of Protivin and Oran soils. They have a dark-colored A horizon that is thinner than that of Protivin soils. Riceville soils contain more clay and have a firmer consistence in the IIB horizon than Oran soils.

Riceville loam, 1 to 4 percent slopes (784B).—This soil is on long, convex sides and broad, rounded crests of ridges. In a few places it is in concave downslope and cove positions. It is associated with the Lourdes, Protivin, Jameston, Schley, and Clyde soils. Areas range from 3 to about 50 acres in size in most places. In a few places downslope or near a waterway, the subsoil is stratified and is more friable than is typical.

This soil is moderately well suited to row crops. The more sloping areas are subject to slight erosion if cultivated. Because of the variability in permeability of the loamy overburden and the high-density underlying glacial till at a depth of about 1½ feet, water accumulates at their contact surface and produces a temporary high water table, particularly early in spring. A combination of terracing and tile drainage is needed to provide for adequate erosion control and drainage. Careful placement and spacing of tile is important because of the slowly permeable subsoil. The organic-matter content in this soil is moderate. (Capability unit IIw-3; woodland suitability group 7)

Rockton Series

The Rockton series consists of dark-colored, well drained soils on uplands. These soils are nearly level in high areas and gently sloping to moderately sloping on long sides of ridges. They formed in 20 to 40 inches of loamy material and a thin layer of limestone residuum over limestone bedrock. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown, black, and dark-brown loam 15 inches thick. The subsoil, which extends to a depth of 28 inches, is dark yellowish-brown clay loam over a 4-inch layer of dark yellowish-brown clay residuum. The substratum, which extends to a depth of 40 inches, is hard, shattered limestone that contains some sandy loam material. Below this is level-bedded limestone bedrock.

Rockton soils have moderate to low available water capacity and moderate permeability. They are very low in available phosphorus and potassium. These soils are acid in reaction and need lime unless they have been limed within the last 5 years.

Representative profile of Rockton loam, moderately deep, 2 to 5 percent slopes, 164 feet east and 105 feet north of the southwest corner of NE¼ sec. 28 T. 99 N., R. 11 W., in a cornfield on a convex, east-facing slope of 3 percent:

Ap—0 to 7 inches, black (10YR 2/1) loam; moderate, fine granular structure; friable; few roots; very few small pebbles; slightly acid; clear, smooth boundary.

A1—7 to 11 inches, very dark brown (10YR 2/2) heavy loam; moderate, very fine, granular structure; friable; few roots; very few small pebbles; slightly acid; clear, wavy boundary.

A3—11 to 15 inches, dark-brown (10YR 3/3) heavy loam; nearly continuous very dark brown (10YR 2/2) ped coatings; moderate, fine, subangular blocky structure; friable; very few pebbles; slightly acid; clear, wavy boundary.

B21t—15 to 24 inches, dark yellowish-brown (10YR 4/4) clay loam; dark-brown (10YR 3/3) ped coatings; weak, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; firm; few, dark-brown (7.5YR 3/2), patchy clay films; about 4 percent is pebbles ⅛ to ½ inch in diameter; slightly acid; clear, wavy boundary.

IIB22t—24 to 28 inches, dark yellowish-brown (10YR 4/4) light clay; continuous brown (7.5YR 4/4) and dark yellowish-brown (10YR 4/4) clay films on prism and ped faces; moderate, medium, prismatic structure parting to strong, fine, subangular blocky; very firm; about 4 percent is fine gravel; few fine and medium pores; few roots along structure faces and very few roots that penetrate the peds; neutral; abrupt, wavy boundary.

IIR1—28 to 40 inches, shattered limestone fragments dominantly ranging from ½ inch to 8 inches; about 20 percent yellowish-brown (10YR 5/4) fine sandy loam; strongly effervescent, mildly alkaline.

IIR2—40 to 60 inches, hard, level-bedded, fractured limestone bedrock.

Depth of the loamy overburden ranges from 20 to 40 inches, and the clay residuum is 2 to 8 inches thick over shattered bedrock. The moderately deep Rockton soils range from 20 to 30 inches in thickness, and the deep Rockton soils range from 30 to 40 inches. The A horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). It is 10 to 15 inches of loam to gritty silt loam. The upper part of the B horizon ranges from loam to clay loam. The IIB2t horizon, or clayey residuum, ranges from dark yellowish brown (10YR 4/4) to yellowish red (5YR 4/8) and is 2 to 6 inches thick. The shattered upper part of the limestone bedrock ranges from 2 to 5 feet in thickness. It contains 10 to 20 percent loamy material and a thin layer of clayey residuum on slabs of limestone. As slope increases, thickness of the shattered bedrock decreases. Reaction is slightly acid to medium acid in the most acid horizon.

Rockton soils formed in material similar to the parent material of Winneshiek and Whalan soils. They have a dark-colored A horizon that is thicker than that of Winneshiek soils.

Rockton loam, deep, 0 to 2 percent slopes (213A).—This soil has a profile similar to the one described as representative for the series, except that depth to limestone bedrock is 30 to 40 inches in most places. In some spots the bedrock is within 20 inches of the surface, and in other places it is at a depth of about 60 inches. In most places this soil is on high ridges above areas of the gently sloping Rockton soils on uplands. Areas range

from 2 to 100 acres in size, but most are about 4 to 20 acres.

This soil is well suited to the row crops grown in the county. It has few limitations, and there are few major management needs. In years when rainfall is less than average, this soil is somewhat droughty. The organic-matter content of this soil is high. (Capability unit I–2; woodland suitability group 6)

Rockton loam, deep, 2 to 5 percent slopes (213B).—This soil has a profile similar to the one described as representative for the series, except that depth to limestone bedrock is 30 to 40 inches in most places. In some spots the bedrock is within 20 inches of the surface, and in other places it is at a depth of about 60 inches. This soil is on long, convex sides and crests of ridges above areas of the more sloping Rockton soils. Terril soils occupy many of the drainageways adjacent to this soil. Areas range from 2 acres to about 60 acres in size but generally are about 4 to 8 acres.

Included in mapping in some places are small spots of eroded soils that have a dark-brown surface layer that is lower in content of organic matter than this Rockton soil.

This soil is well suited to row crops commonly grown in the county. If cultivated, it is subject to slight erosion. It is somewhat droughty in years when rainfall is below average. The organic-matter content of this soil is high. (Capability unit IIe–1; woodland suitability group 6)

Rockton loam, deep, 5 to 9 percent slopes (213C).—This soil has a profile similar to that described as representative for the series, except that depth to limestone bedrock is generally 30 to 40 inches. This soil is on the sides of ridges and in many places is below long, narrow, horizontal bands of Sogn soils. Nearly level to gently sloping Terril soils are in many of the drainageways adjacent to this soil. The areas range from 2 acres to about 8 acres in size. Included on some of the foot slopes are areas where the dark surface layer is 20 to 30 inches thick. In a few places the bedrock is within 20 inches of the surface, and in other places it is at a depth of about 60 inches.

Included in mapping in some places are spots of eroded soils that have a brown and dark-brown surface layer. In some places there are areas of steeper soils.

This soil is well suited to row crops if rainfall is timely. It is somewhat droughty in years when rainfall is below average. It is subject to moderate to severe erosion if it is cultivated. Shallowness of bedrock interferes with terrace construction in places. The organic-matter content of this soil is high. (Capability unit IIIe–1; woodland suitability group 6)

Rockton loam, moderately deep, 0 to 2 percent slopes (214A).—This soil is mostly in high areas on uplands above gently sloping Rockton soils. Areas range from 2 to 100 acres in size but generally are about 5 to 20 acres. Limestone bedrock is at a depth of 24 to 30 inches in most places. In some spots it is within 12 inches of the surface, and in a few places it is at a depth below 36 inches.

This soil is well suited to row crops when rainfall is timely. It tends to be droughty in years when rainfall is average or below average. The organic-matter content of the soil is high. (Capability unit IIs–1; woodland suitability group 3)

Rockton loam, moderately deep, 2 to 5 percent slopes (214B).—This soil has the profile described as representative for the series. It is on the long, convex sides and crests of ridges above areas of the more sloping Rockton soils. Terril soils occupy many of the drainageways. Areas range from 2 acres to about 60 acres in size but generally are about 4 to 8 acres. Depth to limestone bedrock is 20 to 30 inches in most areas. In a few places the bedrock is below a depth of 36 inches, and in other spots it is near the surface or is exposed. Exposed spots of limestone are shown on the soil map by a special symbol.

Included in mapping in some places are small spots of eroded soils that have a dark-brown surface layer.

This soil is well suited to row crops when rainfall is timely. It has a slightly limited root zone and is subject to slight erosion if cultivated. This soil tends to be droughty in years when rainfall is average or below average. Construction of terraces is difficult in some places because of the shallowness to limestone bedrock. The organic-matter content of this soil is high. (Capability unit IIe–4; woodland suitability group 3)

Rockton loam, moderately deep, 5 to 9 percent slopes (214C).—This soil is on ridge crests and convex sides of ridges. In many places it is above areas of steep Sogn soils. The nearly level to gently sloping Terril soils are in many of the drainageways. Areas of this Rockton soil range from 2 acres to about 10 areas in size. In some places there are small eroded spots where the surface is brown and dark brown. Depth to limestone bedrock is 20 to 28 inches in most areas. In a few places bedrock is below a depth of 30 inches, and in other spots it is near the surface or is exposed on the surface. Exposed spots of limestone are shown on the soil map by a special symbol.

This soil is moderately well suited to row crops when rainfall is timely. It has a limited root zone and is subject to moderate to severe erosion if cultivated. This soil tends to be droughty in years when rainfall is average or below average. Terrace construction is difficult in some places because of the shallowness to limestone bedrock. The organic-matter content of this soil is high. (Capability unit IIIe–3; woodland suitability group 3)

Rockton loam, moderately deep, 5 to 9 percent slopes, moderately eroded (214C2).—This soil has a profile similar to the one described as representative for the series, except that the dark surface layer is thinner and some of the subsoil is mixed with it. This soil is on the crests and convex sides of ridges. In many places it is above areas of steep Sogn soils. The nearly level to gently sloping Terril soils are in many of the drainageways. The areas of this Rockton soil range from 2 acres to about 10 acres in size. Depth to limestone bedrock is 20 to 26 inches in most areas. In a few places the limestone bedrock is below a depth of 30 inches, and in other spots it is near the surface or is exposed. Exposed spots of limestone are shown on the soil map by a special symbol.

Included in mapping in some places are small spots of severely eroded soils that have a dark yellowish-brown clay loam surface layer.

This soil is moderately well suited to row crops when rainfall is timely. It has a slightly limited root zone and is subject to severe erosion if cultivated. It tends to be droughty in years when rainfall is average or below

average. Terrace construction is difficult in some places because of shallowness to limestone bedrock. This eroded soil is lower in content of organic matter and potassium than the uneroded Rockton soils. The organic-matter content of this soil is moderate. (Capability unit IIIe-3; woodland suitability group 3)

Sattre Series

The Sattre series consists of moderately dark colored, well-drained, level to nearly level soils on stream benches and uplands. These soils formed in about 30 to 40 inches of loamy material and the underlying coarse-textured material. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam 7 inches thick. The subsurface layer is 6 inches of dark grayish-brown, friable loam. The subsoil is brown and dark yellowish-brown, friable loam in the upper part and yellowish-brown sandy loam and loamy sand in the lower part. It extends to a depth of 51 inches. The substratum is yellowish-brown loamy sand.

Sattre soils have a moderate available water capacity. They are moderately permeable in the upper part and rapidly permeable in the lower part. They are very low in content of available phosphorus and potassium and are moderate in content of organic matter. Sattre soils are acid and need lime if they have not been limed within the past 5 years.

Representative profile of Sattre loam, 0 to 2 percent slopes, 740 feet south and 136 feet west of the northeast corner of SE¼ sec. 19, T. 100 N., R. 11 W., in a cornfield on a straight, south-facing slope of ½ percent:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; neutral; clear, smooth boundary.

A2—7 to 13 inches, dark grayish-brown (10YR 4/2) and very dark grayish-brown (10YR 3/2) loam, light gray (10YR 7/2) and pale brown (10YR 6/3) when dry; weak, medium, platy structure; nearly continuous very dark brown (10YR 2/2) ped faces; friable; neutral; clear, wavy boundary.

B21t—13 to 20 inches, brown (10YR 4/3) loam that has nearly continuous dark-brown (10YR 3/3) prism and ped coatings; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; few very dark grayish-brown (10YR 3/2) clay films on prism and ped faces; medium acid; gradual, smooth boundary.

B22t—20 to 29 inches, dark yellowish-brown (10YR 4/4) loam; brown (10YR 4/3) ped coatings; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; friable; few very dark grayish-brown (10YR 3/2) clay films on prism and ped faces; band of pebbles ¼ inch to 1 inch in diameter in lower fringe; strongly acid; clear, smooth boundary.

B31—29 to 39 inches, yellowish-brown (10YR 5/4) heavy sandy loam; weak, coarse, subangular blocky structure; very friable; few, hard, dark reddish-brown (5YR 2/2) oxides; few pebbles; strongly acid; gradual, smooth boundary.

IIB32—39 to 48 inches, yellowish-brown (10YR 5/4) loamy sand; very weak, coarse, subangular blocky structure; very friable; few, fine, soft, strong-brown (7.5YR 5/6) oxides; few small pebbles; strongly acid; clear, smooth boundary.

IIB33—48 to 51 inches, light yellowish-brown (10YR 6/4) loamy sand; very weak, coarse, subangular blocky structure; very friable; few, small, soft, yellowish-red (5YR 5/8) oxides; strongly acid; clear, smooth boundary.

IIC—51 to 66 inches, yellowish-brown (10YR 5/4) loamy sand; few, fine, soft, strong-brown (7.5YR 5/6) oxides; massive; loose; strongly acid.

The loamy overburden over the contrasting textures of loamy sand and sand ranges from 30 to 40 inches in thickness. The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) loam to gritty silt loam. It is 6 to 10 inches thick. The A2 horizon is 3 to 6 inches thick and ranges from loam to silt loam that contains enough sand to feel gritty. In some places the A2 horizon is mixed into the plow layer. The B2 horizon is heavy loam, light clay loam, or sandy clay loam. The C horizon ranges from loamy sand that contains some gravel to medium and coarse sand that contains gravel. The amount of gravel in these soils is variable, and some layers are 20 to 50 percent gravel by volume. Depth to carbonates is more than 6 to 8 feet. The solum is medium acid to strongly acid in the most acid horizon.

Those Sattre soils in this county that have a relatively thick B3 horizon of sandy loam are outside the range defined for the series, but this does not alter the usefulness or behavior of those soils.

The Sattre soils formed in materials similar to the parent material of Saude, Wapsie, and Waukee soils. They have a dark-colored A horizon that is thinner than that of Saude and Waukee soils. They are deeper to loamy sand and gravel than Saude and Wapsie soils.

Sattre loam, 0 to 2 percent slopes (778A).—This soil is on stream benches and uplands. On the benches it is associated with the Wapsie, Lawler, Marshan, and many other bench soils, and on uplands it is associated with Racine soils. Most areas are 3 to 12 acres in size. The underlying sandy materials are generally 30 to 36 inches below the surface but range from 24 to 40 inches.

Included in mapping in some places are small areas of soils that have coarse material at a somewhat greater or a lesser depth and a few spots of soils that have a sandy loam surface layer. These soils are shown on the soil map by a symbol.

This soil is well suited to row crops but tends to be droughty in some years unless rainfall is timely. (Capability unit I-2; woodland suitability group 6)

Saude Series

The Saude series consists of dark-colored, well-drained, nearly level to gently sloping soils on stream benches and uplands. These soils formed in 20 to 36 inches of loamy material and the underlying coarse-textured material. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark brown loam 13 inches thick. The subsoil extends to a depth of 28 inches and is dark-brown and dark yellowish-brown, friable loam that grades to friable sandy loam as depth increases. The substratum, which is below a depth of 28 inches, is yellowish-brown loamy sand and dark yellowish-brown gravelly coarse sand.

Saude soils have moderate to low available water capacity. Permeability is moderate in the medium-textured material and rapid to very rapid in the coarse-textured substratum. These soils are low in available phosphorus and very low in available potassium. In most places reaction is medium acid to strongly acid and in these places these soils need lime unless they have been limed within the past 5 years. In some places the soils are slightly acid to neutral and seldom need liming.

Representative profile of Saude loam, 0 to 2 percent slopes, 47 feet east and 67 feet north of the southwest

corner of sec. 14, T. 98 N., R. 14 W., in a level, cultivated field:

Ap—0 to 7 inches, black (10YR 2/1) loam; moderate, fine granular structure; friable; neutral; clear, smooth boundary.
A1—7 to 13 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) ped coatings; weak, fine, subangular blocky structure parting to weak, fine, granular; friable; medium acid; gradual, smooth boundary.
B1—13 to 16 inches, dark-brown (10YR 3/3) loam; few very dark grayish-brown (10YR 3/2) ped coatings; weak, fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.
B21—16 to 24 inches, dark yellowish-brown (10YR 4/4) loam; dark-brown (10YR 3/3) and dark yellowish-brown (10YR 3/4) ped coatings; weak, medium, subangular blocky structure; friable; medium acid; gradual, smooth boundary.
B22—24 to 28 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam; weak, medium, subangular blocky structure; friable; medium acid; abrupt, smooth boundary.
IIC1—28 to 36 inches, yellowish-brown (10YR 5/4) loamy sand; single grain; loose; few small pebbles; band of pebbles 1 inch to 2 inches in diameter in upper part; strongly acid; clear, smooth boundary.
IIC2—36 to 50 inches, dark yellowish-brown (10YR 4/4) gravelly coarse sand; single grain; loose; medium acid; gradual, smooth boundary.
IIC3—50 to 60 inches, yellowish-brown (10YR 5/6) gravelly coarse sand; single grain; loose; medium acid.

The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/1) and is 10 to 16 inches thick. Texture ranges from loam to silt loam that contains enough sand to feel gritty. Thickness of the loamy material over the contrasting texture ranges from 20 to 36 inches. The B2 horizon ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/4). Texture is dominantly light loam to medium loam to a depth of 18 to 24 inches and light loam to sandy loam below that depth. Clay content of the B2 horizon ranges from 15 to 20 percent, but the weighted average is less than 18 percent. The C horizon is dominantly gravelly sand but ranges from loamy sand to coarse sand that contains some gravel. Gravel in the C horizon is 5 to 15 percent by volume, but in some layers it is 20 to 50 percent. On uplands the sand or gravel substratum is generally 5 to 12 feet thick but ranges from 2½ feet to more than 15 feet. The substratum material is underlain by glacial till of a sandy loam or clay loam texture. Depth to calcareous material is more than 90 inches on the benches and 70 inches on uplands.

Saude soils formed in material similar to the parent material of Sattre, Wapsie, and Waukee soils. They have a dark-colored A horizon that is thicker than that of Sattre and Wapsie soils. They are more shallow to loamy sand material than Sattre and Waukee soils.

Saude loam, 0 to 2 percent slopes (177A).—This soil has the profile described as representative for the series. It is on stream benches and uplands. On the stream benches it is associated with the Waukee, Lawler, and Marshan soils, and on uplands it is associated with the Ostrander and Racine soils. Where this soil is on stream benches, it is associated with more poorly drained soils that are suited to shallow wells. On benches there is more likely to be a hazard of pollution if septic filter fields are installed in this soil than where this soil is associated with the Racine and Ostrander soils on uplands. Most of these areas are 3 to 30 acres in size. Sandy material is typically 22 to 30 inches below the surface but ranges from 20 to 36 inches.

Included in mapping in a few places are soils that have a sandy surface layer. These are shown on the soil map by a symbol. Also included are a few areas of soils that have a thin, very dark grayish-brown surface layer.

This soil is well suited to row crops but is somewhat droughty during extended dry periods. The organic-matter content of this soil is high. (Capability unit IIs–1; woodland suitability group 3)

Saude loam, 2 to 5 percent slopes (177B).—This soil is on benches of larger streams, along smaller streams, and on uplands where gravel is near the surface. On stream benches it is associated with the Waukee, Lawler, and other bench soils, and on uplands it is associated with the Ostrander and Racine soils. Septic filter fields installed in this soil where it occurs on stream benches are more likely to cause pollution of shallow wells than those installed in areas on uplands. Most areas are about 3 to 15 acres in size. A few small areas of this soil have a thinner and browner surface layer. Sandy material is generally at a depth of 20 to 30 inches but ranges to 36 inches. A few acres have gravelly material above a depth of 20 inches.

Included in mapping in a few places is a sandy soil that is shown in the map by symbol. Also included are a few areas of steeper soils.

This soil is well suited to row crops, but it is subject to slight erosion if cultivated. It is slightly droughty. The organic-matter content of this soil is high. (Capability unit IIe–4; woodland suitability group 3)

Saude sandy loam, 0 to 2 percent slopes (284A).—This soil has a profile similar to the one described as representative for the series, except that it has a sandy loam surface layer 12 to 20 inches thick. Also, a few pebbles are in the surface layer and the upper part of the subsoil. Gravelly sand is at a depth below about 24 to 40 inches in most places. In some areas gravelly material is within 8 to 12 inches of the surface and a few spots have a gravelly surface layer and are shown on the soil map by a symbol. This soil is mostly on stream benches and is associated with Saude, Sattre, and Burkhardt soils. Generally the areas are about 2 to 10 acres in size.

This soil is moderately suited to row crops when rainfall is sufficient and timely. It is somewhat excessively drained and is droughty. If cultivated, this soil is subject to slight soil blowing. The organic-matter content of this soil is moderate. (Capability unit IIIs–1; woodland suitability group 3)

Saude sandy loam, 2 to 5 percent slopes (284B).—This soil has a profile similar to the one described as representative for the series, except that it has a sandy loam surface layer 12 to 20 inches thick. Also, a few pebbles are throughout the surface layer and the upper part of the subsoil. This soil is mostly on uplands and is adjacent to areas of the Ostrander, Racine, and Burkhardt soils. Where it occurs on stream benches, it is associated with Saude and Wapsie soils. Most areas are about 2 to 10 acres in size. A few are as large as 20 acres. Gravelly sand is at a depth below 24 to 40 inches. There are gravelly spots on the surface in some places. These are shown on the soil map by a symbol. In a few small areas, glacial till is below a depth of about 20 to 30 inches.

This soil is moderately well suited to row crops when rainfall is normal and timely. It is droughty and is subject to slight water erosion and soil blowing if it is cultivated. The organic-matter content of these soils is moderate. (Capability unit IIIe–4; woodland suitability group 3)

Schley Series

The Schley series consists of moderately dark colored, somewhat poorly drained soils on uplands. These soils have slightly convex to concave slopes of 1 to 4 percent and are on side slopes and in coves. They formed in 30 to 50 inches of loamy material and the underlying stratified, medium-textured and moderately coarse textured, friable sediment and glacial till. In some places there is a layer of pebbles at the contact surface of the loamy overburden and the stratified sediment or on the surface of the glacial till. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is black silt loam 7 inches thick. The subsurface layer is dark grayish-brown silt loam 10 inches thick and contains enough sand to feel gritty. The subsoil is mottled strong-brown and grayish-brown, stratified loam and sandy loam that extends to a depth of 46 inches. The substratum is yellowish-brown, strong-brown, and light-gray, friable and firm loam.

Schley soils have high available water capacity and moderate permeability. Content of available phosphorus and potassium is very low, and content of organic matter is moderate. These soils are acid and need lime unless they have been limed within the past 5 years. Wetness of the Schley soils, at least in part, is a result of hillside seepage from the higher lying Bassett and Kenyon soils. If drained, these soils are commonly used for row crops.

Representative profile of Schley silt loam, 1 to 4 percent slopes, 752 feet west and 42 feet south of the northeast corner of sec. 27, T. 98 N., R. 13 W., in a cornfield on an east-facing slope of 1½ percent:

Ap—0 to 7 inches, black (10YR 2/1) silt loam, gray (10YR 5/1) when dry; cloddy parting to moderate, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A21—7 to 13 inches, dark grayish-brown (10YR 4/2) silt loam; light brownish gray (10YR 6/2) and pale brown (10YR 6/3) when dry, dark grayish brown (10YR 4/2) when kneaded; weak, fine and medium, platy structure; friable; very strongly acid; clear, smooth boundary.

A22—13 to 17 inches, dark grayish-brown (10YR 4/2) silt loam, pale brown (10YR 6/3) when dry; common, fine, faint, grayish-brown (10YR 5/2) mottles and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, platy structure parting to weak, fine, subangular blocky; friable; very strongly acid; clear, wavy boundary.

B21—17 to 22 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) light loam; weak, medium-prismatic structure parting to weak, medium and fine, subangular blocky; friable; very strongly acid; clear, wavy boundary.

B22t—22 to 37 inches, mottled strong-brown (7.5YR 5/6) and grayish-brown (2.5Y 5/2) heavy sandy loam; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; friable; nearly continuous grayish-brown (2.5Y 5/2) silt and sand prism coatings that are light gray (10YR 7/2) when dry; clay bridging between many sand grains; few, fine, soft, yellowish-red (5YR 5/8) oxides and few, fine, firm, dark reddish-brown (5YR 2/2) oxides; strongly acid; clear, wavy boundary.

IIB3t—37 to 46 inches, strong-brown (7.5YR 5/8) loam; common, medium, distinct, grayish-brown (2.5Y 5/2) mottles; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; friable; few clay films line pores and root channels; fine, firm, dark reddish-brown (5YR 2/2) oxides and oxide coatings are common in the upper part and decrease to few with depth; few pebbles; strongly acid; clear, wavy boundary.

IIC1—46 to 54 inches, yellowish-brown (10YR 5/6) and light-gray (5Y 6/1) loam; massive; firm; few, fine, soft, dark reddish-brown (5YR 3/2) oxides; few pebbles; slightly acid; gradual, smooth boundary.

IIC2—54 to 63 inches, strong-brown (7.5YR 5/6) loam; common, medium, prominent, gray and light-gray (5Y 6/1) mottles; massive; friable; few, fine, soft, dark reddish-brown (5YR 3/2) oxides; few pebbles; neutral; clear, wavy boundary.

The A1 or Ap horizon is generally black (10YR 2/1) or very dark gray (10YR 3/1) but ranges to very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick. The A2 horizon ranges from dark graylish brown (10YR 4/2) to grayish brown (10YR 5/2) but has some mottles that are browner. Thickness of the A2 horizon is generally 6 to 10 inches. Texture of the A horizon ranges from silt loam that contains enough sand to feel gritty to loam. The B2 horizon ranges from light loam to silt loam that contains enough sand to feel gritty or light clay loam, but strata of sandy loam are present. The IIB horizon ranges from heavy sandy loam to loam and sandy clay loam and has some lenses or pockets of sand and sandy loam. Reaction of the solum is generally strongly acid or very strongly acid. The pH value gradually increases in the IIB3 and IIC horizons. Depth to carbonates is more than 60 inches.

Schley soils formed in materal similar to the parent material of Floyd, Clyde, and Hayfield soils. They have a thinner dark-colored A horizon and are more acid throughout than Clyde or Floyd soils. Schley soils have a substratum that is not so coarse in texture as that of Hayfield soils.

Schley silt loam, 1 to 4 percent slopes (407B).—This soil is mostly in slightly convex to concave areas. It is downslope from the better drained glacial till soils, such at Kenyon, Bassett, and Cresco soils, and is upslope from Clyde soils. Most areas are 3 to 20 acres in size. The glacial till, below a depth of 40 inches, is clay loam in places.

Included in mapping in a few areas are small spots of soils that have dense, dark-gray to nearly black silty clay or heavy clay loam below a depth of 20 to 40 inches. Also included are a very few areas that have dark, compacted silty material below a depth of 40 inches. In a few areas are soils that have a sandy loam suface layer. Most of these are associated with a sandy ridge that runs southeasterly from section 34 in Albion Township through section 3 in Vernon Springs Township.

This soil is well suited to row crops when properly drained. Although it can be farmed without tile drainage, tile drainage is beneficial to the soil and permits field-work to be accomplished earlier. The major limitation is wetness, but some areas are subject to erosion. Since wetness, at least in part, is a result of sidehill seepage, a drainage system that intercepts the water that moves laterally through the soil is the most effective one. In areas where soil loss is a concern, a combination of terraces and tile drains can be used. (Capability unit IIw-2; woodland suitability group 8)

Sogn Series

The Sogn series consists of dark-colored, somewhat excessively drained soils on uplands and on terrace escarpments. These soils are gently sloping on long ridge crests and steep on short sides of ridges. Slopes range from 2 to 40 percent, but most are less than 25 percent. Near the streams and rivers are some vertical and nearly vertical escarpments of limestone. These soils formed in 4 to 20 inches of loamy material over limestone bedrock. In some places a thin, clayey layer is just above the lime-

stone bedrock. The native vegetation was dominantly mixed prairie grasses and some trees.

In a representative profile the surface layer is black and very dark grayish-brown loam 9 inches thick. The substratum is 1 to 3 feet of hard, shattered limestone that contains some sandy loam material. The substratum is underlain by level-bedded limestone bedrock.

Sogn soils have very low available water capacity and moderate permeability. They are low in available phosphorus and potassium. These soils are neutral.

Representative profile of Sogn loam, 5 to 14 percent slopes, 1,160 feet south and 60 feet east of the northwest corner of SW¼ sec. 13, T. 39 N., R. 11 W., in a pastured timber area on a convex east-facing slope of 6 percent:

A1—0 to 5 inches, black (10YR 2/1) heavy loam; moderate, fine, granular structure; friable; many roots; few rounded limestone fragments; neutral; clear, wavy boundary.

A3—5 to 9 inches, very dark grayish-brown (10YR 3/2) heavy loam; weak, fine, subangular blocky structure; friable; common roots; 50 percent of horizon is rounded limestone fragments ¼ inch to 2 inches in size; mildly alkaline; clear, irregular boundary.

IIR—9 inches, shattered limestone; fragments in upper few inches are softer and are brown (10YR 6/3) on the exterior and very pale brown (10YR 7/3) with streaks of yellow (10YR 7/6) in the interior; upper 1 to 3 feet is commonly shattered and contains 5 to 10 percent sandy loam.

Depth to hard limestone ranges from 4 to 20 inches. In some places a thin, discontinuous layer of heavy, clayey material 1 to 4 inches thick is just above the bedrock or is mixed with the surface layer. The shattered upper layer of limestone, which is 1 to 3 feet thick, contains 5 to 15 percent of a soil material that ranges from sandy loam to loamy sand. In places the upper layer of the limestone contains bits of clayey material in the upper few inches on the slabs and in the crevices. The thickness of the shattered limestone generally decreases as slope increases.

Sogn soils in this county have a better moisture relationship than is typical for the Sogn series.

Sogn soils formed in material similar to the parent material of the Backbone, Rockton, and Winneshiek soils. They are more shallow to limestone bedrock than these soils.

Sogn loam, 2 to 5 percent slopes (412B).—Most of this soil is above areas of more sloping Sogn soils or on sides of ridges below areas of level to gently sloping Rockton or Winneshiek soils. Most slopes are rather long. Generally the areas of this soil are 2 to 10 acres in size, but they are as much as 60 acres. Depth to limestone bedrock is 10 to 15 inches in most areas. In some places the bedrock is near the surface or is exposed on the surface as shattered limestone or as fragments. In a few spots the depth to bedrock is 15 to 30 inches.

This soil is poorly suited to row crops. It has a limited root zone and is droughty. In a few places exposed bedrock or limestone fragments interfere with cultivation. This soil is subject to slight erosion if it is cultivated. Terrace construction is difficult because of shallowness to bedrock. The organic-matter content of this soil is high. (Capability unit IVs-2; woodland suitability group 1)

Sogn loam, 5 to 14 percent slopes (412D).—This soil has the profile described as representative for the series. It is on side slopes below areas of the less sloping Sogn soils and the Rockton and Winneshiek soils, or it is above areas of the steeper Sogn soils. The nearly level to gently sloping Terril soils occupy many of the drainageways below this soil. About 55 percent of the acreage has slopes of 5 to 9 percent, and the rest has slopes of 9 to 14 percent. Most areas are 2 to 5 acres in size, but some areas are as much as 40 acres. The soil in about one-third of the acreage has been moderately eroded and is lower in organic matter than in uneroded areas. Where slopes are 5 to 9 percent, the limestone is 7 to 13 inches below the surface in most places. Where slopes are 9 to 14 percent, the limestone is generally 4 to 12 inches below the surface. There are many outcrops of limestone, especially in areas of the steeper slopes. Most of these outcrops are shattered or fragmented. There are a few exposures of hard, level-bedded limestone.

Included in mapping are a few areas of soils where the limestone is below a depth of 13 to 25 inches.

This soil is poorly suited to row crops. It has a limited root zone and is droughty. Tilth is poor in some of the eroded areas. Exposed bedrock and limestone fragments interfere with cultivation in many places. If this soil is cultivated, it is subject to moderate to severe erosion. The steeper areas are better suited to hay or pasture than to field crops. Terrace construction is difficult because of the limestone. The organic-matter content of this soil is moderate. (Capability unit VIs-1; woodland suitability group 1)

Sogn loam, 14 to 40 percent slopes (412F).—This soil has a profile similar to the one described as representative for the series, except that the surface layer is 4 to 5 inches thick. This soil is steep on short side slopes below areas of less sloping Sogn soils and the Rockton, Winneshiek, and Backbone soils. Many areas of this soil occupy long, narrow, horizontal strips that extend across some of the less sloping soils. Most areas are 2 to 5 acres in size, but some areas are as much as 30 acres. A few areas are 1 to 4 acres in size and consist of 50 to 70 percent exposed limestone. Limestone bedrock is at a depth of 4 to 10 inches in much of the acreage. There are many outcrops of shattered limestone and limestone fragments. In some places, hard, level-bedded limestone is exposed. Most of this Sogn soil has slopes of less than 25 percent. The steepest areas of this soil occupy many of the limestone escarpments.

Included in mapping are a few areas of soils that have a silty and sandy surface layer.

This soil is not well suited to row crops. It is droughty and has a very limited root zone. It is better suited to hay or pasture than to row crops. The organic-matter content of this soil is moderate. (Capability unit VIIs-1; woodland suitability group 1)

Sparta Series

The Sparta series consists of dark-colored, excessively drained soils on uplands and benches. Slopes are 0 to 9 percent on upland and 0 to 5 percent on benches. These soils formed in very sandy alluvial or eolian deposits. Native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loamy fine sand about 14 inches thick. The subsoil, which extends to a depth of 41 inches, is brown and yellowish-brown loamy fine sand and sand. The substratum is yellowish-brown, loose fine sand that contains brown bands about 1 inch thick interspersed throughout.

The Sparta soils have very low available water capacity. Permeability is rapid to very rapid. Content of

available phosphorus and potassium is very low to low. Sparta soils are acid and need lime unless they have been limed within the past 4 years.

The Sparta soils hold little moisture and are very droughty. They are subject to both soil blowing and water erosion. Because of their variability of occurrence, their use is generally determined by the use of adjacent soils.

Representative profile of Sparta loamy fine sand, 2 to 5 percent slopes, 310 feet east and 80 feet north of the northeast corner of a homestead in NW¼ sec. 5, T. 98 N., R. 11 W., in a cultivated field on a convex, south-facing slope of 4 percent:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loamy fine sand; weak, fine, granular structure; very friable; neutral; abrupt, smooth boundary.

A1—7 to 10 inches, very dark brown (10YR 2/2) loamy fine sand; weak, fine, granular structure; very friable; medium acid; clear, smooth boundary.

A3—10 to 14 inches, very dark grayish-brown (10YR 3/2) loamy fine sand; very weak, medium, subangular blocky structure parting to weak, fine, subangular blocky; very friable; medium acid; clear, wavy boundary.

B21—14 to 22 inches, brown (10YR 4/3) loamy fine sand; very weak, fine subangular blocky structure; very friable; medium acid; diffuse, smooth boundary.

B3—22 to 40 inches, yellowish-brown (10YR 5/4) fine sand; very weak, coarse, subangular blocky structure; single grain; loose; slightly acid; clear, wavy boundary.

B22t—40 to 41 inches, brown (7.5YR 4/4) heavy loamy fine sand; weak, fine, subangular blocky structure; clay-iron bridging; friable; slightly acid; abrupt, smooth boundary.

C—41 to 66 inches, yellowish-brown (10YR 5/6) fine sand; single grain; loose; 1-inch clay-iron bands at a depth of 48 and 57 inches; slightly acid.

The A horizon is generally very dark brown (10YR 2/2) but ranges to very dark grayish brown (10YR 3/2) and is 12 to 20 inches thick. The texture of this horizon is generally loamy fine sand but ranges to loamy sand and fine sand. Below a depth of 20 to 40 inches, the sand grains are commonly fine and medium. Thin B2t horizontal lenses of dark-brown loamy fine sand 1 to 3 inches thick are at intervals of 6 to 8 inches below a depth of 36 inches in some areas. Depth to calcareous material is 70 inches or more. Reaction is medium acid to strongly acid in the most acid part of the B horizon.

Sparta soils formed in material similar to the parent material of the Backbone, Dickinson, and Lamont soils. They have a dark-colored A horizon that is thicker than that of Backbone and Lamont soils. They contain less clay and more sand in the solum than Backbone, Dickinson, or Lamont soils. The solum of Sparta soils is not terminated by limestone bedrock as is that of Backbone soils.

Sparta loamy fine sand, 0 to 2 percent slopes (41A).—This soil is on benches, primarily along the larger streams. Most areas are 2 to 5 acres in size, but in a few places along the Upper Iowa River they are 10 to 20 acres in size. In a few places along the Upper Iowa River, the dark-colored surface layer is more than 30 inches thick. This soil is generally free of gravel but some areas on stream benches have gravel below a depth of 30 inches.

This soil is moderately well suited to row crops, depending on the amount and timeliness of rainfall. It is excessively drained and is droughty. It is subject to soil blowing in spring if the surface is left unprotected. The organic-matter content of this soil is moderately low. (Capability unit IVs–1; woodland suitability group 2)

Sparta loamy fine sand, 2 to 5 percent slopes (41B).—This soil has the profile described as representative for the series. It mostly has convex slopes and is generally adjacent to streams on uplands. In a few places this soil is on benches. It is associated with many soils. Areas are generally about 2 to 4 acres in size, but a few areas in section 12 of Vernon Springs Township are larger. This soil generally is free of gravel, but in some areas it has a few pebbles. In a very few places, gravelly material is at a depth below 30 inches. Such areas are primarily along streams.

This soil is moderately well suited to row crops, depending on the amount and timeliness of rainfall. It is excessively drained and droughty. It is subject to slight soil blowing if the surface is left unprotected, and to water erosion if it is cultivated. The organic-matter content of this soil is moderately low. (Capability unit IVs–2; woodland suitability group 2)

Sparta loamy fine sand, 5 to 9 percent slopes (41C).—This soil has convex slopes and is on uplands. It occupies a few narrow escarpments and includes some areas that are strongly sloping. Most of the acreage is near streams. Areas generally are about 2 to 4 acres in size, but one area in section 1 of Vernon Springs Township is about 20 acres in size. This soil is generally free of gravel, but in some areas it has a few pebbles.

Included in mapping are a few areas of soils that have a surface layer of fine sand 15 to 25 inches thick.

This soil is poorly suited to row crops. It is excessively drained and is droughty. It is subject to soil blowing and water erosion if it is cultivated. Most areas are not large enough to be farmed separately. (Capability unit IVs–2; woodland suitability group 2)

Spillville Series

The Spillville series consists of dark-colored, nearly level, moderately well drained to somewhat poorly drained soils on bottom lands. These soils are mainly on flood plains of the rivers and along narrow, intermittent streams. They formed in medium-textured alluvial sediment. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black loam that extends to a depth of 43 inches. The subsoil is black, friable loam and is 9 inches thick. The substratum is black and very dark gray loam that has thin strata of sandy loam and is mottled with gray.

Spillville soils have high available water capacity and moderate permeability. They are medium in available phosphorus and very low in available potassium. Reaction is generally medium acid to slightly acid, and the soils need lime if lime has not been added within the past 5 years. In some areas these soils are slightly acid to neutral, and lime generally is not needed.

Representative profile of Spillville loam, 85 feet south of bridge and 120 feet west of road fence in SE¼SE¼ sec. 36, T. 98 N., R. 13 W., in a permanent pasture on a level, first bottom:

A11—0 to 8 inches, black (10YR 2/1) loam; moderate, fine and very fine, granular structure; friable; medium acid; gradual, smooth boundary.

A12—8 to 18 inches, black (10YR 2/1) light loam; weak, fine and very fine, angular structure; friable; medium acid; gradual boundary.

A13—18 to 29 inches, black (10YR 2/1) loam; weak, fine and very fine, granular structure; friable; few, fine, soft, dark reddish-brown (5YR 2/2 and 3/4) oxides; medium acid; gradual, smooth boundary.

A14—29 to 43 inches, black (10YR 2/1) heavy loam; weak, fine, subangular blocky structure; friable; few, fine, soft, dark reddish-brown (5YR 2/2) oxides; medium acid; gradual, smooth boundary.

B—43 to 52 inches, black (10YR 2/1) loam; few very dark gray (10YR 3/1) ped coatings; weak, medium, subangular blocky structure; friable; few fine pores; slightly acid; clear, smooth boundary.

C—52 to 60 inches, black (10YR 2/1) and very dark gray (10YR 3/1) loam; few, fine, faint, dark-gray (10YR 4/1) mottles; stratified very dark grayish-brown (10YR 3/2) sandy loam and loamy coarse sand; massive, friable; few, fine, soft, dark-brown (7.5YR 3/3) oxides in and adjacent to the coarse strata; slightly acid.

The dark-colored A1 horizon ranges from about 36 to 60 inches in depth, but generally it is more than 40 inches deep. The A horizon ranges from loam to silt loam that contains enough sand to feel gritty. Mottles below the A horizon, or below a depth of 36 inches, range from few to many; chroma is 1 to 4, and value is 3 to 5. Texture below the A horizon is generally loam, but in places it is sandy loam or clay loam. Depth to calcareous material is more than 60 inches. Reaction of the solum is commonly neutral to medium acid.

Spillville soils formed in material similar to the parent material of Turlin soils, acid variant, and Colo and Terril soils. They have a thicker A1 horizon than Turlin soils, acid variant. They are better drained than Colo soils. Spillville soils have a thicker A1 horizon and a lower chroma in the B and C horizons than Terril soils.

Spillville loam (0 to 2 percent slopes) (485).—This soil is on flood plains and in some narrow upland valleys. A profile of this soil is described as representative of the series. Most areas range from about 3 to 20 acres in size. This soil is associated with the Colo-Alluvial land complex and with Colo; Turlin, acid variant; and Ankeny soils.

Included in mapping are spots of sandy soils and small areas of wet soils in places. These are shown on the soil map by a symbol.

This soil is well suited to row crops. There are no major limitations to management, but some areas are subject to occasional flooding. Tile drainage generally is not needed. The organic-matter content of this soil is high. (Capability unit I–1; woodland suitability group 9)

Spillville-Colo complex (0 to 2 percent slopes) (585).—The soils in this complex are on flood plains of the rivers and streams. Topography is quite uniform, but there are a few depressional areas and discontinuous stream channels. A permanent or intermittent stream runs through most areas. On the larger stream bottoms, the Spillville soils make up about 60 to 70 percent of the area. On the more narrow stream bottoms, Colo soils dominate. Areas of this complex range from about 3 to 100 acres in size.

Flood control and some artificial drainage are needed for this complex. It is well suited to row crops. Some areas are in pasture because of the frequency of flooding. The organic matter content of these soils is high. (Capability unit IIw–4; woodland suitability group 9)

Spillville-Colo complex, channeled (0 to 2 percent slopes) (615).—The soils in this complex are on flood plains of the rivers and streams. Discontinuous stream channels and swales are numerous. On the larger stream bottoms, the Spillville soils make up about 60 to 70 percent of the areas. On the more narrow stream bottoms, Colo soils dominate. Areas range from about 3 to 100 acres in size.

Included in mapping are a few areas of sandy soils deposited by flood water.

The soils in this complex are not suited to row crops, because of the many channels and the hazard of flooding. They are better suited to permanent pasture, timber, or for wildlife areas. The organic-matter content of these soils is high. (Capability unit Vw–1; woodland suitability group 9)

Terril Series

The Terril series consists of dark-colored, nearly level to gently sloping, well-drained soils on uplands. These soils are in upland waterways, in narrow valleys, and on foot slopes adjacent to areas of steep soils. They formed in medium-textured alluvial sediment. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loam 29 inches thick. The subsoil extends to a depth of 47 inches. It is dark-brown and dark yellowish-brown, friable loam in the upper part and grades to yellowish-brown, very friable sandy loam in the lower part. The substratum is yellowish-brown gravelly loamy sand.

Terril soils have high available water capacity and moderate permeability. They are low in available phosphorus and very low in available potassium. The organic-matter content is high. In some areas reaction is neutral to slightly acid, and lime generally is not needed. In other areas reaction is slightly acid to medium acid, and lime is needed if these soils have not been limed within the past 5 years.

Representative profile of Terril loam, 0 to 2 percent slopes, 82 feet south and 62 feet west of the northeast corner of SE¼NE¼ sec. 25, T. 99 N., R. 11 W., in a cultivated field on a north-facing slope of 1 percent:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) ped coatings; weak, fine, granular structure; friable; neutral, clear, smooth boundary.

A1—7 to 21 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) ped coatings; weak, fine, granular structure; friable; few fine pores; neutral; gradual, smooth boundary.

A3—21 to 29 inches, very dark grayish-brown (10YR 3/2) loam; nearly continuous very dark brown (10YR 2/2) ped coatings; weak, fine, granular structure; friable; neutral; clear, smooth boundary.

B21—29 to 39 inches, dark brown (10YR 3/3) loam; discontinuous very dark grayish-brown (10YR 3/2) ped coatings; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; neutral; gradual, smooth boundary.

B22—39 to 44 inches, dark yellowish-brown (10YR 4/4) loam; discontinuous brown (10YR 4/3) ped coatings; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; friable; slightly acid; clear, smooth boundary.

B3—44 to 47 inches, yellowish-brown (10YR 5/6) sandy loam; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; very friable; neutral; abrupt, smooth boundary.

IIC—47 to 57 inches, yellowish-brown (10YR 5/6) gravelly loamy sand; massive; loose; neutral.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) in color and from 20 to 36 inches in thickness. Its texture is loam to silt loam that contains enough sand to have a gritty feel. The B horizon ranges from dark brown (10YR 3/4) to yellowish brown (10YR 5/6) and in places has some mottles in the lower part. It is dominantly loam in texture, but in places it has thin layers of sandy loam above a depth of 36 inches. Reaction of the B horizon is neutral to slightly acid. The C horizon ranges from loam to loamy sand and gravelly sand.

Terril soils formed in material similar to the parent material of Spillville soils and Turlin soils, acid variant. They have a thinner A1 horizon than Spillville soils. They have a higher chroma in the B and C horizons than Turlin soils, acid variant.

Terril loam, 0 to 2 percent slopes (27A).—This soil has the profile described as representative for the series. It is mostly in waterways and is associated with gently sloping to moderately sloping soils that are underlain by limestone. In a few places this soil is in narrow upland valleys that have steep sides, but it is generally in waterways and is associated with sandy soils or soils that have a sand, gravel, or limestone substratum. Areas range from 2 acres to about 15 acres in size. In a few spots limestone bedrock is at a depth below 30 to 40 inches.

This soil is well suited to row crops. There are no major limitations to management, but some areas are subject to floods of short duration. (Capability unit I-1; woodland suitability group 6)

Terril loam, 2 to 5 percent slopes (27B).—These soils are mostly in narrow, upland valleys that have steep sides. Most of the associated soils in these areas are underlain by limestone. Where this soil is in other areas, it is generally associated with sandy soils or with soils that are underlain by sand, gravel, or limestone. Most areas of this soil range from 3 acres to about 30 acres in size. In some areas at the base of foot slopes, below areas of the steep Sogn soils, pieces of limestone are in the surface layer and in the subsoil. In a few spots limestone bedrock is below a depth of 30 to 40 inches.

This soil is well suited to row crops. It is subject to slight sheet and gully erosion if cultivated. In some areas it is subject to runoff from adjacent slopes of higher elevation. (Capability unit IIe-5; woodland suitability group 6)

Tripoli Series

The Tripoli series consists of dark-colored, nearly level, poorly drained soils on uplands. These soils are at the heads and along the upper parts of some of the drainageways. They have slightly concave slopes. They formed in 18 to 28 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones is at the contact surface of the overburden and the glacial till. Native vegetation was mixed prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black and dark olive-gray silty clay loam that is 18 inches thick. The upper part of the subsoil, which extends to a depth of 25 inches, is olive, friable clay loam. The lower part of the subsoil, which reaches to a depth of 44 inches, is mottled gray and yellowish-brown loam. The substratum is mottled gray and yellowish-brown sandy clay loam and loam.

Tripoli soils have high available water capacity. Permeability is moderate in the upper part of these soils and moderately slow in the lower part. Water moves more rapidly in the overburden than in the glacial till. Consequently, it accumulates at their contact surface and causes a seasonal perched water table. Tripoli soils are very low in available phosphorus and potassium. The organic-matter content is high. Reaction is neutral to mildly alkaline, and generally lime is not needed.

Representative profile of Tripoli silty clay loam 100 feet west and 167 feet south of the northeast corner of SW¼ sec. T. 97 N., R. 13 W., in a cultivated field on a slightly convex, east-facing slope:

Ap—0 to 8 inches, black (N 2/0) silty clay loam; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A1—8 to 15 inches, black (N 2/0) gritty silty clay loam that is high in sand; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A3g—15 to 18 inches, dark olive-gray (5Y 3/2) light clay loam; few, fine, distinct, olive (5Y 5/4) mottles; black (10YR 2/1) ped coatings; weak, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B1g—18 to 25 inches, olive (5Y 5/3) light clay loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles and few, fine, faint, olive-brown (2.5Y 4/4) mottles; nearly continuous olive-gray (5Y 4/2) prism and ped coatings; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; friable; neutral; clear, smooth boundary.

IIB2—25 to 32 inches, mottled yellowish-brown (10YR 5/8) and gray (5Y 5/1) heavy loam; nearly continuous gray (5Y 5/1) prism coatings; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; pebble band in upper fringe of horizon; neutral; gradual, smooth boundary.

IIB3—32 to 44 inches, mottled gray (5Y 5/1) and yellowish-brown (10YR 5/8) heavy loam; discontinuous light-gray (5Y 6/1) prism coatings; weak, medium, prismatic structure; firm; neutral; gradual, smooth boundary.

IIC1—44 to 57 inches, mottled gray (5Y 5/1) and yellowish-brown (10YR 5/8) light sandy clay loam; massive with few vertical cleavage planes; firm; mildly alkaline; clear, wavy boundary.

IIC2—57 to 67 inches, mottled gray (5Y 5/1) and yellowish-brown (10YR 5/8) heavy loam; massive; firm; strongly effervescent; mildly alkaline.

The A horizon ranges from black (N 2/0) or very dark gray (10YR 3/1) in the upper part to dark olive gray in the lower part. It is generally silty clay loam that includes enough sand to have a gritty feel, but in places it is light to medium clay loam. The B1 horizon ranges from loam to clay loam. Depth to the firmer IIB horizon is 18 to 28 inches. The IIB horizon ranges from loam to clay loam or sandy clay loam. Depth to calcareous material ranges from 36 to 60 inches. Reaction in these soils ranges from neutral to mildly alkaline.

Tripoli soils formed in material similar to the parent material of Jameston and Readlyn soils. They contain less clay and are not so firm in the lower part of the IIB2 horizon and in the IIC horizon as are the Jameston soils. Tripoli soils are more poorly drained and have more yellow hues in the B1 horizon than Readlyn soils.

Tripoli silty clay loam (0 to 2 percent slopes) (398).—This soil is mostly at the upper end of drainageways. It is associated with the Readlyn, Oran, and Kenyon soils upslope and with Clyde soils farther down the drainageway. Most areas are about 3 to 15 acres in size. In a few places the upper part of the subsoil is brown and has a few grayish mottles. This soil is not so poorly drained as the soil described as representative for the series.

This soil is well suited to row crops if it is properly drained. Tilth generally is good, but the soil puddles if worked when wet. The major limitation is wetness. Tile drainage is needed for good crop growth. (Capability unit IIw-1; woodland suitability group 10)

Turlin Series, Acid Variant

The Turlin series, acid variant, consists of dark-colored, nearly level, somewhat poorly drained soils on

bottom lands. These soils are on flood plains of rivers and narrow intermittent streams. They formed in medium-textured, loamy alluvial sediment.

In a representative profile the surface layer is black, very dark brown, and very dark grayish-brown silt loam 29 inches thick. The subsoil, which extends to a depth of 49 inches, is brown and grayish-brown, friable silt loam. The substratum is mottled dark-brown and grayish-brown, friable loam in the upper part and grayish-brown loamy fine sand in the lower part.

These soils have high available water capacity. Permeability is moderate. They are low in available phosphorus and very low in available potassium. The organic-matter content is high. These soils are generally acid, and lime is needed if they have not been limed within the past 5 years.

Representative profile of Turlin silt loam, acid variant, 300 feet east of the north end of a stand of trees and 155 feet north of field road that follows the edge of pond on a level first bottom in SW¼NW¼SW¼ sec. 31, T. 98 N., R. 12 W.:

Ap—0 to 7 inches, black (10YR 2/1) silt loam that is high in sand; moderate, fine, granular structure; friable; medium acid; clear, smooth boundary.

A12—7 to 16 inches, black (10YR 2/1) silt loam that is high in sand; moderate, fine, granular structure; friable; strongly acid; gradual, smooth boundary.

A13—16 to 22 inches, very dark brown (10YR 2/2) silt loam that is high in sand; nearly continuous black (10YR 2/1) ped coatings; weak, fine, subangular blocky structure to moderate, fine, granular; friable; strongly acid; gradual, smooth boundary.

A3—22 to 29 inches, very dark grayish-brown (10YR 3/2) silt loam that is high in sand; few, fine, faint, brown (7.5YR 4/4) mottles; moderate, fine, subangular blocky structure and moderate, fine, granular; friable; strongly acid; clear, smooth boundary.

B2—29 to 36 inches, brown (10YR 4/3) silt loam that is high in sand; strong-brown (7.5YR 5/6) and light olive-brown (2.5Y 5/4) mottles; nearly continuous dark grayish-brown (10YR 4/2) ped coatings; moderate, medium and fine, subangular blocky structure; friable; very thin, nearly continuous, grainy, light-gray (10YR 7/2) silt and sand coatings when dry; few, fine, soft, dark reddish-brown (5YR 3/2) oxides; medium acid; gradual, smooth boundary.

B31—36 to 43 inches, grayish-brown (2.5Y 5/2) silt loam that is high in sand; common, fine, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; friable; few, soft, dark reddish-brown (5YR 3/4) oxides; medium acid; gradual, smooth boundary.

B32—43 to 49 inches, grayish-brown (2.5Y 5/2) silt loam that is high in sand; common, fine, distinct, dark-brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; weak, medium and coarse, subangular blocky structure; friable; few, medium, soft, dark reddish-brown (5YR 3/3) oxides; medium acid; gradual, smooth boundary.

C1—49 to 65 inches, mottled dark-brown (7.5YR 4/4) and grayish-brown (2.5Y 5/2) loam; masive; friable; common, fine, soft, dark reddish-brown (5YR 3/3) oxides; slightly acid; abrupt, smooth boundary.

IIC2—65 to 78 inches, grayish-brown (2.5Y 5/2) loamy fine sand; common, fine, distinct, dark-brown to brown (7.5YR 4/4) and pale-brown (10YR 6/3) mottles; massive; loose; neutral.

The A horizon ranges from black (10YR 2/1) to very dark brown (10YR 3/1) to very dark grayish brown (10YR 3/2) in color and from 24 to 36 inches in thickness. Texture of the A horizon is dominantly silt loam but ranges to loam that is relatively low in sand content and silty clay loam that is high in sand content. The color of the B horizon centers on 10YR or 2.5Y 4/2, but where mottles are common, the chroma is as much as 3. In places ped exteriors have a value of 3 to a depth of 40 inches or more. The texture of the B horizon ranges from loam or silt loam that is high in content of sand to loam and light clay loam. Depth to coarse-textured material is 48 inches or more. The B horizon is generaly medium acid, but it ranges from slightly acid to strongly acid.

Turlin soils, acid variant, formed in material similar to the parent material of Spillville, Terril, and Colo soils. They have a thinner A1 horizon than Spillville or Colo soils. They have colors that are lower in chroma in the B and C horizons than Terril soils.

Turlin silt loam, acid variant (0 to 2 percent slopes) (96).—This soil is on bottom lands and in many places is adjacent to Colo and Spillville soils. Areas range from about 3 to 30 acres in size.

Included in mapping are a few areas of soils that have a sandy loam surface layer.

This soil is well suited to row crops. Occasionally this soil is wet, and in some places it benefits from tile drainage. It is subject to occasional overflow. Many areas of this soil are cultivated, but a few are pastured or are sparsely wooded. (Capability unit I–1; woodland suitability group 9)

Wapsie Series

The Wapsie series consists of moderately dark colored, nearly level to moderately sloping, well-drained soils on stream benches and uplands. These soils formed in 20 to 36 inches of loamy material and the underlying gravelly loamy sand and sand. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is dark grayish-brown loam 8 inches thick. The subsurface layer is brown, friable loam 5 inches thick. The subsoil, which extends to a depth of 38 inches, is dark yellowish-brown, friable loam and light sandy clay loam grading with depth to friable sandy loam and very friable gravelly loamy sand. The substratum is yellowish-brown gravelly sand.

Wapsie soils have moderate to low available water capacity. Permeability is moderate in the medium-textured material and rapid to very rapid in the coarse-textured material in the substratum. These soils are low in available phosphorus and very low in available potassium. The organic-matter content is moderate. Reaction is medium acid to strongly acid, and lime is needed unless the soil has been limed within the past 5 years.

Representative profile of Wapsie loam, 0 to 2 percent slopes, 1,040 feet north and 225 feet west of the southeast corner of NW¼ sec. 31, T. 98 N., R. 12 W., in a level, cultivated field:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) light loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; friable; medium acid; clear, smooth boundary.

A2—8 to 13 inches, brown (10YR 4/3) light loam, pale brown (10YR 6/3) when dry; moderate, medium, platy structure parting to weak, thin, platy; friable; medium acid; clear, wavy boundary.

B21t—13 to 17 inches, dark yellowish-brown (10YR 4/4) loam; nearly continuous dark yellowish-brown (10YR 3/4) ped coatings; weak, fine, subangular blocky structure; friable; few patchy clay films on ped faces; few very pale brown (10YR 7/3) silt and sand coatings when dry; medium acid; gradual, smooth boundary.

B22t—17 to 27 inches, dark yellowish-brown (10YR 4/4) light sandy clay loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few, patchy, dark-brown clay films on prism and

ped faces; few medium and large pebbles; medium acid; abrupt, smooth boundary.

IIB31—27 to 29 inches, dark yellowish-brown (10YR 4/4) sand loam; weak, coarse, subangular blocky structure; friable; medium acid; clear, smooth boundary.

IIB32—29 to 38 inches, dark yellowish-brown (10YR 4/4) gravelly loamy sand; very weak, coarse, subangular blocky structure; very friable; strongly acid; gradual, smooth boundary.

IIC—38 to 60 inches, yellowish-brown (10YR 5/6) gravelly sand; single grain; loose; strongly acid.

Depth of the loamy overburden over contrasting gravelly sand and loamy sand ranges from 20 to 36 inches. The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) in color, from 6 to 9 inches in thickness, and from loam to silt loam that contains enough sand to have a gritty feed. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3) and from loam to silt loam that contains enough sand to feel gritty. The B horizon is loam or light clay loam that grades to heavy sandy loam and gravelly loamy sand in the lower part. Clay content of the B2 horizon ranges from about 15 to 20 percent, but weighted clay average of the control section to the contrasting textures is less than 18 percent. The C horizon ranges from sandy loam that has some gravel to gravelly sand or gravel that has some sand. The percentage of gravel, by volume, in the coarse underlying material varies, but some strata are between 20 and 50 percent gravel. On uplands the sand and gravel ranges from 2½ feet to more than 15 feet in thickness. Depth to calcareous material is more than 9 feet on stream benches and 6 feet on uplands.

Wapsie soils formed in material similar to the parent material of Saude, Sattre, and Waukee soils. They have a dark-colored A horizon that is thinner than that of Saude and Waukee soils. They are more shallow to sandy material than Sattre and Waukee soils.

Wapsie loam, 0 to 2 percent slopes (777A).—This soil has the profile described as representative for the series It is on stream benches. It is associated with the Sattre, Hayfield, and other bench soils. Most areas are 3 to 40 acres in size. Sandy material is generally at a depth of 22 to 30 inches but ranges from 20 to 36 inches.

Included in mapping are a few areas of soils that have a sandy loam surface layer and a few areas that have a thick, dark-colored surface layer.

This soil is well suited to row crops if rainfall is timely. It is somewhat droughty during extended dry periods. (Capability unit IIs–1; woodland suitability group 3)

Wapsie loam, 2 to 5 percent slopes (777B).—This soil is on the larger stream benches and on uplands. On stream benches it is associated with such soils as the Sattre and Hayfield soils. On uplands this soil is associated with Racine and Ostrander soils. Most areas are about 3 to 20 acres in size. Sandy material is typically at a depth of 20 to 30 inches but ranges to 36 inches. A few areas have gravelly material above a depth of 20 inches, and a few places have a sandy surface layer. There are a few areas of steeper soils.

This soil is well suited to row crops if rainfall is timely. It is subject to slight erosion if cultivated, and it is slightly droughty. On stream benches septic tank filter fields cause more of a pollution hazard than they do on uplands. (Capability unit IIe–4; woodland suitability group 3).

Wapsie loam, 5 to 9 percent slopes (777C).—This soil is generally in high areas on uplands and on stream benches. It is chiefly associated with Racine and Ostrander soils. Areas are 2 to 7 acres in size. Sandy material is generally 20 to 24 inches below the surface but in places it is at a depth of 36 inches. Where this soil is on uplands, the subsoil is more variable than where it is on stream benches.

Included in mapping are spots where gravel is at the surface. These spots are shown on the soil map by a symbol. Also included are spots of soils that have a subsoil of friable glacial till and a few areas of eroded soil that have a brown and dark yellowish-brown surface layer.

This soil is moderately well suited to row crops if rainfall is timely. It is subject to erosion if cultivated, and it is droughty. Terrace cuts need to be held to a minimum so that the sandy material is not exposed. (Capability unit IIIe–3; woodland suitability group 3)

Waukee Series

The Waukee series consists of dark-colored, well-drained, nearly level to gently sloping soils on stream benches. These soils formed in 24 to 40 inches of loamy material and underlying gravelly loamy sand and sand. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark brown loam about 16 inches thick. The subsoil, which extends to a depth of 44 inches, is dark yellowish-brown and yellowish-brown, friable loam and sandy clay loam and very friable fine gravelly loamy sand. The substratum is yellowish-brown fine gravelly sand.

Waukee soils have moderate available water capacity. They are moderately permeable in the upper part and rapidly permeable in the lower part. They are low in available phosphorus and very low in available potassium. Organic-matter content is high. In most places Waukee soils are acid and need lime unless they have been limed in the past 5 years. The Waukee soils in the northeastern part of the county are slightly acid to neutral and seldom need lime.

Representative profile of Waukee loam, 0 to 2 percent slopes, 640 feet west and 100 feet south of the northeast corner of sec. 35, T. 98 N., R. 14 W., in a cultivated field on a slightly convex south-facing slope of 1 percent:

Ap—0 to 8 inches, black (10YR 2/1) loam; moderate, fine and very fine, granular structure; friable; slightly acid; clear, smooth boundary.

A12—8 to 11 inches, black (10YR 2/) loam; moderate, fine, granular structure; friable; medium acid; gradual, smooth boundary.

A13—11 to 16 inches, very dark brown (10YR 2/2) loam; moderate, fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

B1—16 to 20 inches, dark yellowish-brown (10YR 3/4) loam; weak, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B21—20 to 25 inches, dark yellowish-brown (10YR 4/4) heavy loam; weak, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B22—25 to 35 inches, yellowish-brown (10YR 5/6) loam that grades to light sandy clay loam in the lower part; dark yellowish-brown (10YR 4/4) ped coatings; weak, medium, subangular blocky structure; friable; medium acid; clear, smooth boundary.

IIB3t—35 to 44 inches, yellowish-brown (10YR 5/6) fine gravelly loamy sand; very weak, fine, subangular blocky structure; very friable; about 15 percent very fine gravel; clay bridging between some of the sand and gravel; medium acid; gradual, smooth boundary.

IIC—44 to 66 inches, yellowish-brown (10YR 5/6) fine gravelly sand; single grain; loose; few sand grains and pebbles that have very thin clay films; medium acid.

Depth to sandy and gravelly material is generally 30 to 40 inches, but in places it is as little as 24 inches. The A1 or Ap horizon generally is black (10YR 2/1) but ranges to very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2). Thickness of the A horizon is 10 to 18 inches. The B horizon ranges from dark brown (10YR 3/3) to yellowish brown (10YR 5/6) and from loam to sandy clay to a depth of 24 to 40 inches. The B2 horizon ranges from 18 to 27 percent in content of clay. The IIC horizon is dominantly gravelly sand, but it ranges to loamy sand that has some gravel to sandy gravel. Depth to calcareous material is 6 feet or more. Reaction is medium acid to strongly acid in the most acid horizon.

Waukee soils formed in material similar to the parent material of Saude, Sattre, and Wapsie soils. They have a dark-colored A horizon that is thicker than that of Sattre and Wapsie soils. They are deeper to sandy material than Saude soils.

Waukee loam, 0 to 2 percent slopes (178A).—This soil has the profile described as representative for the series. It is on stream benches. It is associated with Saude, Lawler, Marshan, and other bench soils. Most areas are 2 to 12 acres in size. The underlying sandy material is generally 30 to 36 inches below the surface, but the depth ranges from 24 to 40 inches. In some places there are small areas where the coarse material is somewhat deeper or more shallow.

Included in mapping are a few spots of soils that have a sandy loam surface layer.

This soil is well suited to row crops. (Capability unit I–2; woodland suitability group 6)

Waukee loam, 2 to 5 percent slopes (178B).—This soil is generally on stream benches, but a few small areas are on uplands. It is associated with Saude, Lawler, Marshan, and other bench soils. Most areas are 2 to 4 acres in size. The underlying sandy material is generally 30 to 36 inches below the surface, but the depth ranges from 24 to 40 inches. In some places the coarse material is at a somewhat greater or lesser depth.

Included in mapping are a few areas of soils that have a thinner dark-colored surface layer.

This soil is well suited to row crops. It is subject to slight erosion if it is cultivated. (Capability unit IIe–1; woodland suitability group 6)

Whalan Series

The Whalan series consists of light-colored, well-drained, gently sloping to moderately sloping soils on uplands. These soils occupy long ridges and sides of ridges. They formed in 20 to 30 inches of loamy material and a thin layer of limestone residuum that is underlain by limestone bedrock. Native vegetation was trees.

In a representative profile the surface layer is very dark gray loam about 2 inches thick. The subsurface layer is dark grayish-brown, friable loam 9 inches thick. The subsoil is dominantly 17 inches of brown loam and clay loam, but the lower 6 inches is mottled dark-brown and brown clay residuum. To a depth of 60 inches is shattered limestone that has sandy loam material between the slabs. It rests on level-bedded limestone bedrock.

Whalan soils have low available water capacity. Permeability is moderate in the upper part, very slow in the clayey residuum, and very rapid in the limestone bedrock. These soils are low in available phosphorus and very low in available potassium. The organic-matter content is low. These soils are acid in reaction and need lime unless they have been limed within the last 5 years.

Representative profile of Whalan loam, moderately deep, 2 to 5 percent slopes, approximately 790 feet north and 620 feet east of the southwest corner of SE¼ sec. 2, T. 98 N., R. 11 W., in a stand of timber on a convex, east-facing slope of 2 percent:

O2—1 inch to 0, black (10YR 2/1) and very dark brown (10YR 2/2) organic matter that contains a little silty and sandy material.

A1—0 to 2 inches, very dark gray (10YR 3/1) light loam; moderate, fine, granular structure; friable; abundant roots; neutral; clear, smooth boundary.

A2—2 to 11 inches, dark grayish-brown (10YR 4/2), light loam, light brownish gray (10YR 6/2) when dry; very dark grayish-brown (10YR 3/2) stains on ped faces; moderate, fine, platy structure; friable; neutral; clear, wavy boundary.

B1—11 to 15 inches, brown (10YR 4/3) medium loam; nearly continuous dark grayish-brown (10YR 4/2) silt coatings on ped faces, light brownish gray (10YR 6/2) when dry; moderate, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t—15 to 19 inches, brown (7.5YR 4/4) light clay loam; discontinuous dark-brown (10YR 3/3) clay films on ped exteriors; strong, fine, subangular blocky structure; firm; light brownish-gray (10YR 6/2) silt coatings when dry; medium acid; clear, wavy boundary.

IIB22t—19 to 25 inches, mottled dark-brown (7.5YR 3/2) and brown (7.5YR 4/4) light clay; nearly continuous dark-brown clay films on ped faces; strong, fine, angular and subangular blocky structure; very firm; slightly acid; abrupt, wavy boundary.

IIB3t—25 to 28 inches, thin, irregular layer of brownish-yellow (10YR 5/6) yellow (2.5Y 7/6), and pale-yellow (2.5Y 7/4) sandy loam containing a few limestone fragments resting on shattered limestone bedrock; strongly effervescent; mildly alkaline; abrupt, irregular boundary.

IIR1—28 to 60 inches, shattered limestone containing about 10 to 15 percent sandy loam material.

IIR2—60 inches, hard, level-bedded limestone bedrock.

Depth to the loamy material over limestone ranges from 20 to 30 inches. In uncultivated wooded areas, the A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). This horizon is 1 to 4 inches thick. In cultivated areas the Ap horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 4/3). The A2 horizon ranges from dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) to brown (10YR 5/3). In cultivated and eroded areas, the A2 horizon is likely to be incorporated in the Ap horizon. Texture of the A horizon is loam or silt loam that is high in content of sand. The upper part of the B horizon ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/6). The texture is loam or clay loam, and a thin horizon of heavy clay loam or clay, 2 to 6 inches thick, is over the shattered bedrock. The shattered upper layer of limestone ranges from 2 to 5 feet in thickness and contains 10 to 20 percent sandy loam or loamy sand material that has some clayey residuum or shale. Reaction ranges from medium acid to very strongly acid in the most acid horizon.

Whalan soils formed in material similar to the parent material of Rockton and Winneshiek soils. They have a dark-colored A horizon that is thinner than that of Rockton or Winneshiek soils.

Whalan loam, moderately deep, 2 to 5 percent slopes (207B).—This soil has the profile described as representative for the series. It is on long, convex sides and crests of ridges. In most places it is above areas of the more sloping Whalan or Sogn soils. Areas range from 2 to 6 acres in size. In cultivated areas the plow layer is dark grayish brown. Depth to limestone bedrock is 20 to 30 inches in

most areas. In a few places the bedrock is below a depth of 36 inches, and in some spots limestone is near the surface or is exposed. Outcrop areas are shown on the soil map by symbol. In some places the clayey residuum over the limestone is 10 to 12 inches thick.

This soil is well suited to row crops if rainfall is timely. Most areas are covered by trees. The soil has a limited root zone. If cultivated, it is subject to slight erosion. In some years it is droughty. Terracing is difficult in some places because of the limestone bedrock. (Capability unit IIe-4; woodland suitability group 3)

Whalan loam, moderately deep, 5 to 9 percent slopes (207C).—This soil is on the crests and convex sides of ridges. In most places it is below areas of the less sloping Whalan soils and above areas of steep Sogn soils. Areas range from 2 to 5 acres in size. In cultivated areas the plow layer is dark grayish brown. In a few eroded areas, the plow layer is dominantly brown. Depth to limestone bedrock is 20 to 28 inches in most areas. In a few places the bedrock is below a depth of 30 inches, and in other spots it is near the surface or is exposed. Exposed areas of bedrock are shown on the soil map by a symbol.

This soil is moderately well suited to row crops if rainfall is timely. Most areas are covered by trees. The soil has a limited root zone, and it is subject to moderate to severe erosion if it is cultivated. Terrace construction is difficult in places because of the shallow depth of limestone bedrock. (Capability unit IIIe-3; woodland suitability group 3)

Winneshiek Series

The Winneshiek series consists of moderately dark colored, well-drained soils on uplands. They are nearly level in high areas, gently sloping on long ridges, and gently sloping to strongly sloping on side slopes. These soils formed in 20 to 40 inches of loamy material and a thin layer of limestone residuum over limestone bedrock. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is black loam 8 inches thick. The subsurface layer is dark grayish-brown loam 3 inches thick. The subsoil, to a depth of 23 inches, is dominantly dark yellowish-brown loam and clay loam and is underlain by 4 inches of dark yellowish-brown clay. The substratum, which extends to a depth of 60 inches, is hard, shattered limestone that has some clayey residuum between the limestone slabs. It rests on level-bedded limestone bedrock.

Winneshiek soils have moderate to low available water capacity. Permeability is moderate in the surface layer and in the upper part of the subsoil, very slow in the clayey residuum, and very rapid in the limestone bedrock. These soils are low in available phosphorus and very low in available potassium. Reaction is acid, and these soils need lime unless they have been limed within the last 5 years.

Representative profile of Winneshiek loam, moderately deep, 2 to 5 percent slopes, 206 feet north and 90 feet west of the southeast corner of SW¼SE¼ sec. 35, T. 99 N., R. 11 W., in a cultivated field on a convex, west-facing slope of 3 percent.

Ap—0 to 8 inches, black (10YR 2/1) light loam; weak, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A2—8 to 11 inches, dark grayish-brown (10YR 4/2) light loam; light gray (10YR 7/1) when dry; weak, thin, platy structure; friable; medium acid; clear, smooth boundary.

B1—11 to 14 inches, dark yellowish-brown (10YR 4/4) loam; nearly continuous light gray (10YR 7/1) silt and sand coatings on larger peds when dry; weak, medium and fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

B21t—14 to 18 inches, dark yellowish-brown (10YR 4/4) heavy loam; light-gray (10YR 7/1) silt and sand coatings when dry; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; few, thin, dark-brown clay films on ped faces; strongly acid; clear, smooth boundary.

B22t—18 to 23 inches, dark yellowish-brown (10YR 4/4) light clay loam that has nearly continuous light gray (10YR 7/1) silt and sand coatings when dry; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; few dark-brown clay films on ped faces; few fine pores; strongly acid; abrupt, wavy boundary.

IIB23t—23 to 27 inches, dark yellowish-brown (10YR 4/4) light clay; moderate, fine and medium, subangular blocky structure; very firm; discontinuous, very dark gray (10YR 3/1), patchy clay films on vertical ped faces and nearly continuous very dark grayish-brown (10YR 3/2) clay films on horizontal ped faces; slightly acid; abrupt, wavy boundary.

R1—27 to 60 inches, shattered limestone that contains about 15 percent sandy loam material; some clayey residuum between top few fractured slabs, which are generally less than 1 inch thick.

R2—60 inches, hard, level-bedded, limestone bedrock.

Depth to the loamy material over the limestone ranges from 20 to 30 inches in the moderately deep Winneshiek soils, and from 30 to 40 inches in the deep Winneshiek soils. In uncultivated areas the A1 horizon is black (10YR 2/1) to very dark brown (10YR 2/2) and is 6 to 9 inches thick. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3) and from 3 to 6 inches in thickness. The A horizon ranges from loam to silt loam that contains enough sand to feel gritty. In cultivated areas the A2 horizon is likely to be incorporated in the Ap horizon. The upper part of the B horizon ranges from dark brown (10YR 4/3) or dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) in color and from loam to clay loam or sandy clay loam in texture. The clayey residuum, which is just above the bedrock, ranges from 2 to 6 inches in thickness. The shattered upper layer of limestone, which is 2 to 5 feet thick, contains 10 to 20 percent material that ranges from sandy loam to loamy sand; in places bits of clayey material are on the slabs and in the upper few inches of the crevices. Generally, as slope increases there is a decrease in the thickness of the shattered limestone. Reaction is medium acid to strongly acid in the most acid horizon.

The Winneshiek soils in this county that are strongly acid in the B1 and B2 horizons are outside the range defined for the series, but this difference does not alter their usefulness or behavior.

Winneshiek soils formed in material similar to the parent material of Rockton and Whalan soils. They have a dark-colored A horizon that is thinner than that of Rockton soils. They have a dark-colored A horizon that is thicker than that of Whalan soils.

Winneshiek loam, deep, 0 to 2 percent slopes (713A).—This soil has a profile similar to the one described as representative for the series, except that bedrock is generally at a greater depth. In most places this soil is on uplands above the gently sloping Winneshiek soils. Areas range from 2 to 50 acres in size but are generally about 4 to 10 acres. Depth to limestone bedrock is 30 to 40 inches in most places. In some spots the bedrock is within 20 inches of the surface, and in others it is below a depth of 60 inches.

This soil is well suited to row crops. A few areas are in timber and grass. This soil has no major limitations to

use and management, but in some years it is somewhat droughty in places. The organic-matter content of this soil is moderate. (Capability unit I–2; woodland suitability group 6)

Winneshiek loam, deep, 2 to 5 percent slopes (713B).—This soil has a profile similar to the one described for the series, except that bedrock is generally at a greater depth. It is on long, convex sides and crests of ridges above areas of the more sloping Winneshiek soils. Some areas of this soil are in timber and grass. The areas range from about 2 to 60 acres in size but are generally about 4 to 8 acres. Depth to limestone bedrock is 30 to 40 inches in most places. In some spots the bedrock is within 20 inches of the surface, and in others it is below a depth of 60 inches.

This soil is well suited to row crops. It is subject to slight erosion if it is cultivated. The organic-matter content of this soil is moderate. (Capability unit IIe–1; woodland suitability group 6)

Winneshiek loam, deep, 5 to 9 percent slopes (713C).—This soil has a profile similar to the one described as representative for the series, except that bedrock is generally at a greater depth. It is on the sides of ridges and in many places is above areas of steep Sogn soils. The length of slope varies. Areas range from 2 acres to about 20 acres in size but are generally less than 10 acres. Depth to limestone bedrock is 30 to 40 inches in most places. In some spots the bedrock is within 20 inches of the surface, and in others it is below a depth of 60 inches.

Included in mapping are some areas of eroded soils that have a brown surface layer. Also included in places are soils that are steeper than this soil.

This soil is moderately well suited to row crops if rainfall is timely. Some areas are in timber and grass. This soil is subject to erosion if it is cultivated. The organic-matter content is moderate. (Capability unit IIIe–1; woodland suitability group 6)

Winneshiek loam, moderately deep, 0 to 2 percent slopes (714A).—This soil is mostly on uplands above areas of the gently sloping Winneshiek soils. Areas range from 2 to 50 acres in size but are generally 4 to 10 acres. Depth to limestone bedrock is 24 to 30 inches in most places. In some spots bedrock is within 12 inches of the surface, and in a few places it is below a depth of 36 inches.

Included in mapping near the Upper Iowa River near Lime Springs are a few areas of soils in which the clayey subsoil is 6 to 40 inches thick.

This soil is well suited to row crops if rainfall is timely. Some areas are in timber and grass. In years of average or below-average rainfall, this soil is somewhat droughty. The organic-matter content of this soil is moderate. (Capability unit IIs–1; woodland suitability group 3)

Winneshiek loam, moderately deep, 2 to 5 percent slopes (714B).—This soil has the profile described as representative for the series. It is on long, convex sides and crests of ridges above areas of the more sloping Winneshiek soils. Areas range from 2 acres to about 60 acres in size but are generally about 4 to 8 acres. Depth to limestone bedrock is 20 to 30 inches in most areas. In a few places the bedrock is below a depth of 36 inches, and in other spots it is near the surface or is exposed. The areas of exposed bedrock are shown on the soil map by a symbol.

Included in mapping in some places are small spots of eroded soils that have a brown surface layer. Near the Upper Iowa River near Lime Springs are areas of soils that have a clayey lower subsoil that is 6 to 40 inches thick.

This soil is well suited to row crops if rainfall is timely. Some areas are in timber and grass. This soil is somewhat droughty in years of average or below-average rainfall. Terrace construction is difficult in some places because of shallowness to limestone bedrock. The organic-matter content of this soil is moderate. (Capability unit IIe–4; woodland suitability group 3)

Winneshiek loam, moderately deep, 5 to 9 percent slopes (714C).—This soil is on crests and convex sides of ridges, and in many places it is above areas of steep Sogn soils. Areas range from 2 acres to about 20 acres in size but are generally less than 10 acres. Depth to limestone bedrock is 20 to 28 inches in most areas. In a few places bedrock is below a depth of 30 inches, and in other spots it is near the surface or is exposed. The areas of exposed bedrock are shown on the soil map by a symbol.

Included in mapping are a few areas of eroded soils that have a browner surface layer than this Winneshiek soil.

This soil is moderately well suited to row crops if rainfall is timely. It is droughty in years when rainfall is average or below average. Terrace construction is difficult in some places because of the shallow depth of limestone bedrock. The organic-matter content of this soil is moderate. (Capability unit IIIe–3; woodland suitability group 3)

Winneshiek loam, moderately deep, 5 to 9 percent slopes, moderately eroded (714C2).—This soil has a profile similar to the one described as representative for the series, except that the surface layer is less dark and contains part of the subsoil. This soil is on the crests and convex sides of ridges, and in many places it is above areas of steep Sogn soils. Areas range from 2 to about 20 acres in size but are generally less than 10 acres. The eroded areas of this soil have a lower content of organic matter and potassium than the uneroded Winneshiek soils. Depth to limestone bedrock is 20 to 26 inches in most areas. In a few places bedrock is below a depth of 30 inches, and in other spots it is near the surface or is exposed. The exposed areas are shown on the soil map by a symbol.

Included in mapping are some areas of uneroded soils that are in timber and grass. Included also are small spots of severely eroded soils that have a surface layer of dark yellowish-brown clay loam.

This soil is moderately well suited to row crops if rainfall is timely. It has a limited root zone. If cultivated, this soil is droughty and subject to erosion. Terrace construction is difficult in some places because of the shallowness of limestone bedrock. The organic-matter content of this soil is moderately low. (Capability unit IIIe–3; woodland suitability group 3)

Winneshiek loam, moderately deep, 9 to 14 percent slopes (714D).—This soil is mostly on the short sides of ridges or the upper part of the long sides of ridges. In many places it is above the steep Sogn soils. Areas generally range from 2 to 8 acres in size. Depth to limestone bedrock is 20 to 26 inches in most places. In a few areas the bedrock is below a depth of 30 inches, and in many

places it is near the surface or is exposed. The exposed areas are shown on the soil map by a symbol.

This soil is poorly suited to row crops. It has a slightly limited root zone and is subject to erosion if it is cultivated. Terrace construction is difficult in some places because of the shallowness to limestone bedrock. In a few spots it is too steep for terraces. The organic-matter content of this soil is moderate. (Capability unit IVe-2; woodland suitability group 3)

Winneshiek Series, Shaly Subsoil Variant

The Winneshiek series, shaly subsoil variant, consists of moderately dark colored, moderately well drained soils on uplands. These soils are dominantly nearly level and in low areas within 3 miles of Bonair, but a few small areas just west of Cresco occupy high positions on the landscape. They formed in 20 to 30 inches of loamy material over fine-textured shale. Native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam 8 inches thick. The subsurface layer is dark grayish-brown, friable loam 7 inches thick. The upper part of the subsoil is dark yellowish brown, friable loam that extends to a depth of 22 inches. The lower part of the subsoil is olive-yellow and light yellowish-brown silty clay that extends to a depth of 44 inches. The substratum is shattered limestone bedrock.

Winneshiek soils, shaly subsoil variant, have moderate available water capacity. They are moderately permeable in the overburden and very slowly permeable in the shale. These soils are very low in available phosphorus and potassium. The organic-matter content is moderate. These soils are acid, and they need lime unless they have been limed within the past 5 years. The water table is perched within 20 to 30 inches of the surface during extended wet periods.

Representative profile of Winneshiek loam, shaly subsoil variant, 0 to 2 percent slopes, 900 feet south and 440 feet west of the northeast corner of NW$\frac{1}{4}$ sec. 5, T. 99 N., R. 11 W., in a nearly level pasture:

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; moderate, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A2—8 to 15 inches, dark grayish-brown (10YR 4/2) loam; moderate, fine, subangular blocky structure; friable; light brownish-gray (10YR 6/2) when dry; medium acid; clear, smooth boundary.

B1—15 to 22 inches, dark yellowish-brown (10YR 4/4) loam; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; thin, discontinuous, light brownish-gray (10YR 6/2) silt and sand coatings when dry; few small pebbles; band of pebbles ½ inch to 2 inches in diameter; strongly acid; clear, smooth boundary.

IIB2t—22 to 35 inches, olive-yellow (2.5Y 6/6) heavy silty clay; moderate, very fine, prismatic structure parting to moderate, fine, angular blocky; firm; thin, discontinuous, dark-gray (10YR 4/1) clay films on prism and ped faces, discontinuous very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) clay films lining pores and root channels; very few small pebbles; neutral; gradual, smooth boundary.

IIB3t—35 to 44 inches, light yellowish-brown (2.5Y 6/4) silty clay; moderate, very fine, prismatic structure parting to moderate, fine, angular blocky; firm; few, thin, patchy clay films on prism faces and lining some of the pores and root channels; occasional small pebbles; strongly effervescent, mildly alkaline; abrupt, wavy boundary.

R—44 inches, shatered limestone bedrock that contains about 10 percent silty clay in upper 2 inches.

The depth of the loamy material over shale ranges from 20 to 30 inches. The Ap horizon is dominantly loam, but in places it is silt loam that contains enough sand to have a gritty feel. Color ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2), and thickness ranges from 6 to 10 inches. The A2 horizon ranges from loam to silt loam that contains enough sand to have a gritty feel. This horizon is 5 to 9 inches thick. In cultivated and eroded areas, the A2 horizon in most places is in the Ap horizon. The IB horizon above the shale is dominantly loam and sandy clay loam. In places a thin layer of sand or gravelly material less than 8 inches thick is directly above the shale or the IIB horizon. Minimum thickness of the shale is 20 inches. Depth to limestone ranges from 40 inches to more than 120 inches.

Winneshiek soils, shaly subsoil variant, formed in material similar to the parent material of the Jacwin and Winneshiek soils. They have a thinner dark-colored A horizon and higher chroma in the B horizon than Jacwin soils. They are underlain by a layer of clayey shale that is absent in the other Winneshiek soils.

Winneshiek loam, shaly subsoil variant, 0 to 2 percent slopes (148A).—This soil is in low-lying, benchlike areas on uplands in most places, but west of Cresco it is in higher areas on uplands. In most places this soil is associated with soils that are underlain by limestone. Most areas are 2 to 4 acres in sizes, but some are as much as 15 acres.

Included in mapping are a few areas of soils, especially in law areas about 1 mile west of Bonair, that have a shale substratum that begins at a depth of 30 to 50 inches. Also included, west of the airport at Cresco, are a few areas of soils that have shale within 10 inches of the surface, and a few spots of soils, near Bonair, where slopes are as much as 3 percent.

This soil is well suited to row crops if rainfall is timely. (Capability unit IIs-1; woodland suitability group 7)

Use and Management of the Soils

This section briefly describes the use and management of the soils in the county for crops and pasture; describes the system of capability classification used by the Soil Conservation Service; discusses the use and management of groups of soils, or capability units; and gives a table showing management and yield data for all the soils in the county. In addition, it discusses woodland and names trees suitable for planting on each of the soils in the county and gives facts about the soils that affect their suitability for engineering practices.

The information given in this section is not a substitute for the detailed advice that can be provided by a local representative of the Soil Conservation Service or by the county extension director. It can, however, help the farmers or others plan suitable management for the soils.

Use of the Soils for Crops

In Howard County about 238,000 acres, or 79 percent of the acreage of the county, is used for crops. About 36,000 acres, or 12 percent of the county, is used for pasture.

Corn, soybeans, oats, and legume-grass are the main farm crops. Most of the permanent pasture in the county

is bluegrass. Some have been renovated, and birdsfoot trefoil has been introduced. Grass-legume mixtures, such as alfalfa-bromegrass, are also pastured. Most of the permanent bluegrass pastures are not cropped, because they are too wet and need tile drainage. Each year many acres are tile drained and the land converted to cropland. The Clyde, Floyd, and Marshan soils are the dominant ones remaining in pasture that need tile drainage.

Many of the soils are subject to erosion. The major soils that need erosion control are the Kenyon, Bassett, Racine, Lourdes, Cresco, Downs, Fayette, and Ostrander soils. Providing adequate erosion control and drainage at the same time is difficult, because the two measures conflict to some extent. In all these soils except the Fayette and Downs soils, water moves more rapidly in the uppermost part of the profile than in the underlying glacial till, and the water accumulates at the surface of the till. This causes a seasonally perched water table and sidehill seepage in wet years. Because of this difficulty, a combination of terracing and tiling is most likely to be effective. Gully control structures and grassed waterways control gullying in watercourses.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for trees, or for engineering.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the paragraphs that follow.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.
- Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes. (None in Howard County.)

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in some parts of the United States, but not in Howard County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIw–2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Howard County are described, and suggestions for the use and management of the soils are given. The names of the soil series represented in a capability unit are given in the descriptions of the capability unit, but this does not mean that all the soils of a given series appear in the unit. To find the names of all the soils in a given capability unit, refer to the "Guide to Mapping Units" at the back of the survey.

CAPABILITY UNIT I–1

This capability unit consists of nearly level, well-drained and somewhat poorly drained soils on flood plains and in narrow valleys on uplands. These are soils of the Radford, Spillville, and Terril series and of the Turlin series, acid variant.

The Turlin soils, acid variant, are not so well aerated as the other soils. All of these soils generally have good tilth. They are subject to occasional flooding, and the

Turlin soils, acid variant, need tile drainage in some years.

The soils in this unit are well suited to row crops and to hay and pasture plants.

CAPABILITY UNIT I–2

This capability unit consists of nearly level, well-drained to somewhat poorly drained soils on uplands and benches. These are soils of the Bassett, Oran, Ostrander, Racine, Readlyn, Sattre and Waukee series and mapping units of Hayfield, Lawler, Rockton, and Winneshiek series having "deep" as part of their name.

The soils in this unit generally have good tilth. The somewhat poorly drained Lawler, Oran, Readlyn, and Hayfield soils are not so well aerated as the other soils in this unit, and they benefit from tile drainage in some years.

The Rockton and Winneshiek soils are underlain by limestone bedrock at a depth of 30 to 40 inches, and the Sattre and Waukee soils are underlain by sand and gravel at a depth of 30 to 40 inches. These four soils are somewhat droughty in some years unless rainfall is timely. A seasonal high water table in the Hayfield, Lawler, and Readlyn soils is likely to delay spring planting. Unless rainfall is sufficient and timely the Lawler and Hayfield soils are droughty, because they are underlain by sand and gravel at a depth of about 3 feet.

All of these soils are well suited to row crops and to hay and pasture plants.

CAPABILITY UNIT IIe–1

This capability unit consists of gently sloping, well drained and moderately well drained soils on uplands and benches. These are soils of the Bassett, Coggon, Downs, Kenyon, Ostrander, Port Byron, Racine, Renova, Rockton, Waukee, and Winneshiek series.

All of these soils are well aerated and generally have good tilth. The Rockton, Waukee, and Winneshiek soils are underlain by sand and gravel or bedrock at a depth of about 3 feet. These three soils are somewhat droughty if rainfall is below average or is not timely.

The soils in this unit are well suited to row crops and to oats, hay, and pasture plants. Nearly all the acreage is cultivated, and corn and soybeans are the major crops.

The major management needs are controlling erosion, maintaining organic-matter content and fertility, and improving and maintaining tilth. If these soils are terraced, they are suited to intensive row cropping. If Rockton and Winneshiek soils are terraced, the depth of cuts should be held to a minimum so that the underlying limestone is not exposed in the terrace channels. Exposure of glacial till in the Bassett and Kenyon soils needs to be held to a minimum, because these soils have low fertility and unfavorable characteristics for tillage. Unless these soils have been limed within the past 4 or 5 years, they are acid and lime is needed for good growth of crops. The Fayette and Downs soils have a higher content of available phosphorous in the subsoil than the other soils in this unit.

CAPABILITY UNIT IIe–2

This capability unit consists of gently sloping, moderately well drained soils on uplands. These are soils of the Cresco, Donnan, and Lourdes series.

These soils have a very firm subsoil below a depth of about 20 to 30 inches. These soils are slowly and very slowly permeable, and movement of water and air is somewhat restricted in the subsoil.

Most areas of these soils are cultivated and are used mainly for corn. They are suited to row crops and to hay and pasture plants.

The major management concern is slow and very slow permeability in the subsoil. Controlling erosion, maintaining organic-matter content and fertility, and improving and maintaining tilth are the major management needs. Providing adequate drainage and controlling erosion at the same time, however, are difficult because the two measures conflict to some extent. The long, uniform slopes are well suited to contouring and terracing. These practices slow the movement of surface water and let more of it soak into the soil. The extra water entering the soil complicates the drainage condition, especially in wet years. A combination of terraces and tile drains is needed to alleviate the drainage and erosion difficulties. If these soils are terraced, the depth of cuts should be held to a minimum so that the underlying very firm subsoil is not exposed in the terrace channels. Careful placement and spacing of tile drains are important because permeability is slow and very slow in the subsoil.

CAPABILITY UNIT IIe–3

This capability unit consists of gently sloping, somewhat poorly drained soils on uplands. These are soils of the Oran and Readlyn series.

These soils are not well aerated and have a seasonal high water table. Tilth generally is good. In wet years these soils need tile drainage, and in many years timeliness of fieldwork is improved by tile drains.

Most areas of these soils are cultivated and are used mainly for corn. The soils are well suited to row crops and to hay and pasture plants.

The major needs in management are controlling erosion, providing proper drainage, maintaining organic-matter content and fertility, and improving and maintaining tilth. Controlling erosion is also a concern where areas are subject to sheet erosion. Providing adequate drainage and erosion control at the same time is difficult. A combination of such practices as terracing and tiling provides drainage and also reduces erosion. If these soils are terraced and drained, they are suited to intensive row cropping without excessive loss of soil. If these soils are terraced, the exposure of glacial till should be held to a minimum because the subsoil is low in fertility.

CAPABILITY UNIT IIe–4

This capability unit consists of gently sloping soils that are well drained and somewhat excessively drained. These soils are on uplands and benches. They are in the Dickinson, Ostrander, Racine, Rockton, Saude, Wapsie, Whalan and Winneshiek series.

All of these soils except the Ostrander and Racine soils are moderately deep over sandy material or limestone bedrock. The soils in this unit are well aerated and generally have good tilth. They have moderate depth for root development and are somewhat droughty in dry periods.

Most of the acreage of these soils is cultivated, but the areas of Whalan soil are dominantly in timber. The soils

in this unit are well suited to row crops and to hay and pasture plants.

The major management needs are control of erosion, conservation of available moisture, maintenance of organic-matter content and fertility, and improvement and maintenance of tilth. Corn plantings should be somewhat less per acre than is recommended for deeper soils, because the root zone is limited. Constructing terraces and grassed waterways and contour farming are practices that help to control runoff and erosion. If conservation practices are used, row crops can be grown frequently in the rotation without excessive soil loss. If terraces are used, corn can be grown more frequently and soil loss is kept to a safe level. If the Whalan and Winneshiek soils are terraced, the depth of cuts should be kept to a minimum so that the underlying limestone bedrock is not exposed in the terrace channels. Also, bedrock is likely to interfere with terrace construction. The soils in this unit need applications of lime and fertilizer.

CAPABILITY UNIT IIe-5

This capability unit consists of gently sloping, well drained and moderately well drained soils in narrow upland drainageways and at the base of slopes. These are soils of the Huntsville, Radford, and Terril series.

These soils are moderately permeable and generally do not need tile drainage. They receive runoff from soils upslope. The soils in some areas where water concentrates are subject to gullying.

Corn is the main crop grown on these soils. The soils are well suited to cultivated crops, but they are commonly associated in an integrated pattern with steeper soils, and their use is determined by the use of the adjoining soils. Areas of these soils that are large enough to be managed separately can be used intensively for row crops. Small areas and surrounding steep areas are commonly left in grass. Diversion terraces that are properly placed upslope to intercept local runoff are beneficial to the soils in this unit.

CAPABILITY UNIT IIw-1

This capability unit consists of nearly level to gently sloping, poorly drained to somewhat poorly drained soils on uplands and benches. These are soils of the Clyde, Floyd, Jameston, Marshan, and Tripoli series.

The Clyde, Floyd, and Jameston soils have stones and boulders on the surface. The soils in this unit have a seasonal high water table unless they are artificially drained.

Most areas of these soils are used for cultivated crops, but many areas of Clyde and Marshan soils are in permanent pasture and need tile drainage before they can be cultivated. If the soils in this unit are drained by tile, they are well suited to cultivated crops and to hay and pasture plants.

The major management needs are providing artificial drainage and maintaining and improving tilth. In areas of Jameston soils, tile lines need to be placed at a shallower depth and closer together than in the other soils of this unit because of compaction and very slow permeability in the lower part of the subsoil. Installation of the drains in the Marshan soils is different because of the sandy material in the substratum. Boulders on the surface of the Clyde soils are likely to interfere with tiling.

CAPABILITY UNIT IIw-2

This capability unit consists of nearly level to gently sloping, somewhat poorly drained soils on uplands. These are soils of the Floyd, Pinicon, and Schley series.

These soils have a seasonal high water table and need tile drainage. In periods of high rainfall and early in spring, the water table is near the surface unless the soils are drained. The soils have good titlth.

If these soils are drained, and they are generally used for row crops, commonly in rotation with oats and a meadow crop. Undrained areas are commonly left in pasture.

The major management concerns are improving drainage and maintaining high fertility. Wetness of the Floyd and Schley soils results, at least in part, from hillside seepage from the Kenyon, Cresco, and Bassett soils upslope. To alleviate the wetness on side slopes, a drainage system that intercepts water that moves laterally through the soil is most effective. In areas where sheet erosion causes excessive loss of soil, a combination of terraces and tile drains can be used.

CAPABILITY UNIT IIw-3

This capability unit consists of nearly level to gently sloping soils on uplands. These are soils of the Donnan, Jacwin, Protivin, and Riceville series.

These soils have a very firm subsoil below a depth of about 20 to 30 inches. The upper part of these soils is moderately permeable, but the lower part is slowly and very slowly permeable, which causes a seasonally perched water table and hillside seeps.

These soils are suited to cultivated crops and to hay and pasture plants.

The major management needs are reducing wetness and maintaining soil fertility, but erosion is likely to be a concern on some of the gently sloping soils. Tile drains are beneficial in these soils in wet years, but the tiles may not drain all areas satisfactorily. In places tiles need to be placed in these soils at a shallower depth and closer together than in other soils of the county, because of compaction and slow and very slow permeability in the lower part of the subsoil. Because wetness results, at least in part, from hillside seepage, a tile system that intercepts the water that moves laterally through the soil is most likely to be effective. Tile may not drain areas of the Jacwin soils satisfactorily, because the underlying shale is very slowly permeable.

In places, if the gently sloping Protivin and Riceville soils are intensively cropped, erosion is a hazard unless mechanical water-control practices are used. Providing adequate drainage and controlling erosion at the same time, however, are difficult because the two measures conflict to some extent. Contouring and terracing slow the movement of surface water and permit more of the water to soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of tile drains and terraces is needed in places. Under intensive management that includes such practices as constructing terraces, row crops can be grown frequently in the rotation.

If these soils are terraced, the depth of cuts should be held to a minimum so that the very firm subsoil is not exposed in the terrace channels.

CAPABILITY UNIT IIw-4

This capability unit consists of nearly level, moderately well drained to poorly drained soils on flood plains and in narrow valleys on uplands. These soils are in the Colo and Spillville series.

The soils in this unit are subject to occasional flooding of short duration. The Colo soils are poorly drained, and tile drainage is beneficial in some years. Good tile outlets, however, are not available in all places. In some areas the soils benefit from flood protection. In narrow drainageways where water is confined, gullies are likely to form.

Corn is the main row crop grown on the soils in this unit. The soils in undrained areas are in pasture. Scattered trees are in a few areas. Where areas are large enough to be farmed separately, the soils are well suited to field crops.

These soils generally do not need lime.

CAPABILITY UNIT IIs-1

This capability unit consists of nearly level, well-drained and somewhat poorly drained soils. These soils are on uplands and benches that are moderately deep over sandy material, limestone bedrock, or shale. These are soils of the Hayfield, Lawler, Rockton, Saude, Wapsie and Winneshiek series and of the Winneshiek series, shaly subsoil variant.

The Hayfield, Lawler, Saude, and Wapsie soils are underlain by sandy material at a depth of about 2 to 3 feet. The Rockton and Winneshiek soils are underlain by limestone bedrock at a depth of about 2 feet, and the Winneshiek soils, shaly subsoil variant, have a subsoil of shale at a depth of about 2 feet.

The Lawler and Hayfield soils are not so well aerated as the other soils. All of the soils generally have good tilth. They have a shallow rooting zone, and unless rainfall is above normal or is timely, the soils are droughty.

Most of the areas of these soils are cultivated and are mainly used for corn. They are well suited to row crops and to hay and pasture plants.

The major management need is the conservation of available moisture in dry years. Corn plantings should be somewhat less per acre than is recommended for deeper soils, because the root zone is limited. In wet years, the Lawler and Hayfield soils benefit from artificial drainage.

CAPABILITY UNIT IIs-2

Only Ankeny sandy loam, 0 to 2 percent slopes, is in this capability unit. This is a nearly level, somewhat excessively drained soil on flood plains and low benches. It is well aerated and has good tilth. In dry periods, it has a somewhat limited moisture reserve because of its moderately coarse texture. It is subject to occasional flooding of short duration.

This soil is generally well suited to row crops and moderately well suited to hay and pasture plants.

The major management needs are the conservation of available water in dry years and the prevention of soil blowing early in the growing season. Corn plantings should be somewhat less per acre than is recommended for finer textured soils, because the moisture reserve is limited. If this soil is cropped, practices that control soil blowing are beneficial.

CAPABILITY UNIT IIIe-1

This capability unit consists of moderately sloping to strongly sloping, well drained and moderately well drained soils on uplands. These are soils of the Bassett, Downs, Fayette, Kenyon, Ostrander, Racine, Rockton, and Winneshiek series.

Most of these soils have high available water capacity, but the Rockton and Winneshiek soils that have limestone at a depth of 30 to 40 inches have moderate to low available water capacity. All of these soils are well aerated and generally have good tilth. The organic-matter content ranges from high to low, depending on the kind of soil and the amount of erosion.

Most of the acreage is cultivated and is used mainly for corn. These soils are suited to row crops such as corn and soybeans, if protected against erosion, and to oats, hay, and pasture.

The major management needs are control of erosion, maintenance of organic-matter content and fertility, and improvement and maintenance of tilth. Using terraces and waterways and farming on the contour help to control runoff and erosion. If the soils are terraced, corn can be grown frequently in the rotation without excessive loss of soil.

In places bedrock interferes with terrace construction on the Rockton and Winneshiek soils. The depth of terrace cuts should be held to a minimum so as not to expose the less fertile subsoil.

CAPABILITY UNIT IIIe-2

This capability unit consists of moderately sloping, moderately well drained soils on uplands. These are soils of the Cresco and Lourdes series.

These soils have a very firm, very slowly permeable subsoil at a depth below 20 to 26 inches. Organic-matter content ranges from high to moderate, depending on the kind of soil and the amount of erosion.

The major management needs are controlling erosion, providing proper drainage, and maintaining fertility. Controlling erosion and providing drainage at the same time, however, are difficult because the two measures conflict to some extent.

Most areas of these soils are used for cultivated crops. Corn is the major crop. If these soils are protected against erosion, they are suited to row crops and to hay and pasture plants. Constructing terraces, using waterways, and farming on the contour are practices that help to control runoff and erosion. Without mechanical erosion-control measures, the use of row crops in the rotation should be limited, and cover crops that protect the soils should be grown. Under intensive management that includes such practices as using terraces and waterways and farming on the contour, more years of row crops and fewer years of close-growing crops can be safely included in the cropping system.

In constructing terraces the depth of cuts should be held to a minimum so that the underlying subsoil of low fertility is not exposed in the terrace channels. Terracing and contouring decrease soil loss, but these practices tend to increase wetness in places. Consequently, a combination of terracing and tiling is needed.

CAPABILITY UNIT IIIe-3

This capability unit consists of moderately sloping, well-drained soils on uplands and benches. These are soils of the Rockton, Wapsie, Whalan, and Winneshiek series. The Rockton, Whalan, and Winneshiek soils are underlain by limestone bedrock at a depth of 20 to 30 inches, and the Wapsie soil is underlain by sandy material at a depth of about 24 to 30 inches.

The soils in this unit are well aerated and generally have good tilth. They have moderate depth for root development, and in dry periods they have a somewhat limited moisture reserve and are droughty unless rains are timely.

Most of the areas of these soils are cultivated, but Whalan soils are mostly in timber. Corn is the major crop grown. These soils are well suited to hay and pasture plants and are moderately well suited to row crops if they are protected against erosion.

The major management needs are control of erosion, conservation of available moisture, and maintenance of organic-matter content and fertility. Corn plantings should be somewhat less per acre than is recommended for deeper soils, because the root zone is limited. Terraces, grassed waterways, and contour farming help to control runoff and erosion. Unless mechanical erosion-control measures are used, row crops should not be grown frequently. Under intensive management that includes such practices as using terraces and grassed waterways and farming on the contour, row crops can be grown in the cropping system more frequently.

The depth of terrace cuts should be held to a minimum on these soils so that the underlying limestone bedrock and sandy material are not exposed in the terrace channels. Limestone bedrock is likely to interfere with terrace construction in some places on the Rockton, Whalan, and Winneshiek soils.

CAPABILITY UNIT IIIe-4

This capability unit consists of gently sloping to moderately sloping, well-drained and somewhat excessively drained soils on uplands and benches. These soils are of the Backbone, Dickinson, Lamont, and Saude series. The Backbone soils are underlain by limestone residuum at a depth of 20 to 40 inches. The Saude soil is underlain by loamy sand that contains some gravel and is at a depth of about 20 to 30 inches. The Lamont and Dickinson soils are underlain by sand and loamy sand at a depth of about 3 feet.

The soils in this unit are well aerated. In dry periods they have a limited available water capacity because of their moderately coarse texture, and unless rains are timely they are somewhat droughty.

Most areas of these soils are cultivated. The main crop is corn. The soils are moderately well suited to row crops and to hay and pasture plants.

The major management needs are the conservation of available water and the control of water erosion and soil blowing. Corn plantings should be less per acre on these soils than is recommended for finer textured soils, because the moisture reserve is limited. Terraces, grassed waterways, and contour farming help to control runoff and erosion. Under intensive management that includes such practices as using terraces and grassed waterways and farming on the contour, row crops can be used frequently in the rotation without excessive soil loss.

The depth of terrace cuts should be held to a minimum to avoid exposing limestone, sand, or gravel. Limestone bedrock is likely to interfere with terrace construction on the Backbone soils.

CAPABILITY UNIT IIIs-1

This capability unit consists of nearly level, well-drained and somewhat excessively drained soils on benches and uplands. These soils are moderately deep over sand and gravel. They are of the Dickinson, Lamont, and Saude series.

These soils are well aerated. In dry periods they have limited available water capacity because of their moderately coarse texture, and unless rain is timely they are somewhat droughty. If these soils are not protected by vegetation, soil blowing is a hazard in some years. Blowing sand sometimes damages newly seeded plants.

Most areas of these soils are cultivated and are used mainly for corn. These soils are suited to row crops and to hay and pasture plants.

These soils are commonly in small areas and are associated with less droughty or even wet soils that require drainage. Consequently, in places the uses of the soils in this unit can be determined by those of the surrounding soils.

The major management needs are the conservation of available water and the prevention of soil blowing. Corn plantings should be less per acre on these soils than is recommended for finer textured soils, because the moisture reserve is limited. If these soils are cropped, practices that control soil blowing are beneficial. Under good management these soils can be used intensively for row crops.

CAPABILITY UNIT IIIw-1

The only soil in this capability unit is Marshan clay loam, depressional. This is a prooly drained soil on stream benches. It is mostly in large flat areas near the Wapsipinicon and Little Wapsipinicon Rivers. This soil is high in organic-matter content. It is subject to occasional flooding. Natural soil aeration is very poor because of a high water table.

Most of this soil is used for permanent pasture. The soil is moderately well suited to row crops if it is artificially drained. If not drained, it is poorly suited to cultivated crops and is more suitable for permanent pasture.

The major management needs are providing artificial drainage and improving and maintaining tilth and fertility. Surface drainage or surface outlets for tile drains are needed to remove the ponded water in places.

CAPABILITY UNIT IIIw-2

This capability unit consists of nearly level to gently sloping, very poorly drained Mucks. These soils have an organic surface layer that ranges in depth from 10 to 60 inches over medium-textured and coarse-textured mineral soil. If these soils are not artificially drained, the water table is at or near the surface, depending on the season. Natural aeration is poor, and the soils are somewhat cold and warm up slowly in spring.

Some areas of these soils are drained and are used for cultivated crops. Most undrained areas are in permanent pasture. Some areas are idle. These soils are unsuitable

for cultivation unless they are drained, and they are not suited to pasture unless they are improved and drained. Undrained areas are wet and boggy and much of the time are too unstable to support the weight of grazing animals. If these soils are drained, they are suited to row crops and can be farmed intensively. The drained areas are more susceptible to early frosts than the areas of undrained soils. For this reason early maturing varieties of corn and soybeans are more suitable for planting than are other varieties.

These soils are generally wet because they are located in or near sidehill seeps or buried springs, where water is frequently under pressure and seeps to the surface. Drainage systems designed to intercept the seepage water are most likely to be successful in these areas. Where tile drains are placed above the mineral soil material, shrinkage of the organic material alters their alinement and the tile drains do not function properly.

CAPABILITY UNIT IIIw-3

This capability unit consists of nearly level, poorly drained to excessively drained soils on flood plains and lower benches. These are soils of the Colo series and areas of Alluvial land that were mapped in a complex with Colo soils. Most areas are large and are on broad flood plains.

The soils in this unit vary in texture, available water capacity, and permeability. On the flood plains the soils are subject to flooding.

These soils are moderately well suited to row crops and to hay and pasture plants, but most of the acreage has not been artificially drained or protected against flooding and is therefore in pasture and timber.

The major management needs are providing artificial drainage on the poorly drained soils and protecting the areas against flooding. Tile drains are difficult to install because of inadequate grade and the difficulty of obtaining good outlets. Some areas are sandy and are droughty in some years or during some part of the growing season. Most areas do not require lime. The addition of fertilizer to unimproved pasture is not profitable.

CAPABILITY UNIT IVe-1

This capability unit consists of moderately steep, well-drained soils on uplands. These are soils of the Downs and Fayette series.

These soils are well aerated and generally have good tilth.

Most areas of the Downs soils are cultivated, and most areas of the Fayette soils are in timber. These soils are better suited to hay and pasture than to row crops. They can be used for row crops occasionally without excessive loss of soil if erosion control practices are applied.

The major management needs are control of erosion, maintenance of organic-matter content and fertility, and improvement and maintenance of tilth.

CAPABILITY UNIT IVe-2

Only Winneshiek loam, moderately deep, 9 to 14 percent slopes, is in this unit. This is a strongly sloping, well-drained soil on uplands. It is underlain at a depth of about 2 feet by limestone bedrock. This soil has moderate depth for root development and a moderate to low available water capacity. In most years there is a hazard of slight to moderate droughtiness.

Some areas of this soil are cultivated, but most areas are in pasture or woodland.

This soil is better suited to hay and pasture plants than to row crops. It can be used for row crops occasionally if erosion-control practices are applied.

The major management needs are control of erosion, conservation of available moisture, maintenance of organic-matter content and fertility, and improvement and maintenance of tilth. The shallow depth to limestone bedrock is likely to interfere with terrace construction, particularly where this soil is closely associated with Sogn soils.

CAPABILITY UNIT IVs-1

This capability unit consists of nearly level, excessively drained soils on uplands and benches. These soils are of the Lilah and Sparta series.

These soils are shallow to moderately deep over sand and gravel.

Permeability is rapid to very rapid in these soils. The soils are well aerated and have good tilth. In dry periods they have a very limited moisture reserve because of their coarse texture. When these soils are not protected by vegetation, soil blowing is a hazard. Crops generally do not respond well unless rainfall is timely and sufficient. In some years lack of moisture is severe.

Many areas of these soils are cultivated and are used mainly for corn. Many small areas of these soils are associated with larger areas of soils that are better suited to crops. As a result the soils of this unit are generally cropped with those soils. The Sparta soils are moderately suited to row crops, and Lilah soils are poorly suited.

The major management needs are the conservation of available water and the control of soil blowing. Corn plantings should be less per acre than is recommended for finer textured soils, because the moisture reserve is limited. If these soils are cropped, practices that control soil blowing are beneficial.

CAPABILITY UNIT IVs-2

This capability unit consists of gently sloping to moderately sloping, somewhat excessively drained and excessively drained soils on uplands and benches. The soils are shallow to moderately deep over sandy and gravelly material and limestone. They are of the Burkhardt, Lilah, Sogn, and Sparta series.

Permeability ranges from moderate to very rapid. The Sogn soils generally have limestone bedrock at a depth of about 12 inches. In some areas the bedrock is exposed. The Burkhardt, Sparta, and Lilah soils are underlain by sandy and gravelly material. The soils are high to low in organic-matter content. In dry periods, there is a very limited moisture reserve in the soils because of their coarse texture. If these soils are not protected by vegetation, soil blowing and water erosion are hazards. Newly seeded crops on these and the adjoining soils are frequently damaged by blowing sand. The Sogn soils are less subject to soil blowing.

Many areas of these soils are cultivated; some are in pasture. These soils are not well suited to row crops, and extreme variation in the response of crops can be expected from year to year because of the severe hazard of drought.

The major management needs are the conservation of available water and the control of water erosion and soil blowing. Corn plantings should be less per acre than is recommended for finer textured soils, because the moisture reserve is limited. Terraces, contour farming, and grassed waterways help to control runoff and erosion. If mechanical erosion-control measures are used, row crops can be grown frequently in the rotation without excessive soil loss. Limestone bedrock in the Sogn soil interferes with mechanical practices (fig. 12).

CAPABILITY UNIT Vw-1

This capability unit consists of nearly level, poorly drained and excessively drained soils on bottom lands. These are soils of the Colo and Spillville series and Alluvial land. The areas are severely channeled and frequently flooded.

Alluvial land is sandy and droughty in some places and is poorly drained in others. The Colo soils are poorly drained, and Spillville soils are moderately well drained to somewhat poorly drained. Many individual areas of these soils are large. A few of the numerous stream channels and swales contain water throughout the year.

Most areas of these soils are in timber or are under a cover of scattered trees and grass. Some areas are used as wildlife habitat and for recreation. Only a few areas are cultivated. In years when the frequency of flooding is less than normal, some small areas are used for crops. The soils in this unit are so frequently flooded and so dissected by old stream channels and by meandering streams that they are generally not suited to cultivation. They are better suited to trees, although open areas can be used for pasture.

CAPABILITY UNIT VIe-1

Only Fayette silt loam, 20 to 30 percent slopes, is in this capability unit. This is a well-drained soil on uplands.

Some areas of this soil are in row crops, but generally only for a year as part of a rotation that is dominantly hay and pasture. Most areas are in timber. Some timbered areas are pastured.

The soil is generally not suited to cultivated crops. It is better suited to hay and pasture. Cleared areas of this soil that are too small for pasture or hay are suitable for use as wildlife areas or for trees (fig. 13).

The major management need is to control erosion. In most places farm machinery can be operated safely, but seeding or harvesting of crops with farm machinery is difficult in places. Some gullies that cut into hillsides need to be shaped and reseeded.

***Figure 12.*—Area of the Sogn soils in capability class IV that is left in grass; the adjoining soils are cultivated.**

CAPABILITY UNIT VIs-1

This capability unit consists of moderately sloping and strongly sloping, somewhat excessive drained and excessively drained soils on uplands. These are soils in the Lilah and Sogn series (fig. 14). They are shallow to sandy and gravelly material or limestone bedrock.

Where these soils occupy small areas associated with soils that are suited to cultivation, they are in row crops. These soils are better suited to hay and pasture than to row crops. Areas too small for pasture or hay are suitable for use as wildlife habitat or for trees.

The major management needs are the conservation of available moisture and the control of erosion. If these soils are overgrazed, erosion is a major concern. The hazard of erosion is very severe, because limestone bedrock or sand and gravel are at a shallow depth. The surface layer in areas of eroded Sogn soils is clayey in some places, and these soils are difficult to till. Many areas of these soils are managed with soils in capability units IIIe-3 and IVe-2. Some areas are associated with steeper Sogn soils. Lilah soils generally need lime.

CAPABILITY UNIT VIIw-1

This capability unit consists of depressional and flat areas of Marsh. The areas are wet throughout the year, and some impound water part of the year. These areas generally are near streams. The water is at or near the surface the year round. Marsh is associated with and includes ponds and intermittent ponds.

Most areas of Marsh cannot be drained adequately for cultivated crops without a large expenditure of money. The quality of pasture in the areas of Marsh is poor because the natural vegetation is cattails, rushes, sedges, and other water-tolerant plants that are unpalatable to grazing animals.

Most areas of Marsh are better suited to wildlife habitat than to most other purposes. Preserved in their natural state, they offer refuge for waterfowl and other wildlife.

CAPABILITY UNIT VIIs-1

Only Sogn loam, 14 to 40 percent slopes, is in this capability unit. This is a somewhat excessively drained soil on uplands. It is shallow to limestone bedrock (fig. 15) and is well aerated. Available water capacity is very low because of shallowness.

In most areas this soil is not suited to cultivated crops. Under very careful management, some of the less steep areas are suited to hay crops. The steeper areas are more suitable for trees and for use as wildlife habitat.

The major management needs are the conservation of available moisture and the control of erosion. Lime is not needed on this soil.

Figure 13.—**Farm pond used to stabilize a gully and to provide a wildlife and recreation area.**

Predicted Yields

The predicted average yields of the principal crops in the county are given in table 2. The estimates are based on a corn yield study made jointly by Iowa State University and the Soil Conservation Service and on observations made by soil scientists and other farm workers who are familiar with the soils.

Yields in table 2 are given for each soil in the county. These yields can be obtained under two levels of management. In columns A are the yields to be expected under common management, or the management most farmers were practicing when this soil survey was made. In columns B are the yields to be expected under a high level of management, which is used by only a small percentage of farmers in the county.

A variation in yields of about 20 percent can be expected from one year to another and between different areas in the county in any particular year. This sizeable variation in yields results from the kind of management used and variations in the amount and timeliness of rainfall during the growing season. Variations in yields also reflect damage caused by insects and disease and other factors.

Use of the Soils for Woodland [2]

Local practices commonly used in the native woodlands have resulted in gradual deterioration of the quality of the trees in Howard County. The early settlers prized the woodlands as sources of fuel, posts and poles, and material for houses, barns, and the repair of implements. They harvested the best trees and left those less desirable in form and species. Gradually, the less desirable trees dominated the woodlands and reduced their economic value. As a result, much of the woodlands became liabilities instead of assets to many farm owners.

Most of the woodlands are used for pasture. Grazing reduces the feasibility of improving the woodlands. Some wooded soils, notably the Backbone, Bassett, Coggon, Downs, Lamont, Racine, and Renova soils and some of the bottom-land soils, are cleared for farming. Many of the more sloping areas are now eroded and need to be replanted to suitable trees if long-term profitable use is to be made of the soils.

Native woodlands that are still in existence can be kept relatively productive for timber crops by use of good management practices. Such practices include pro-

[2] By SYLVAN T. RUNKEL, biologist, Soil Conservation Service.

Figure 14.—**Typical area of Sogn soils in capability unit VIs-1. This area is along the Turkey River.**

tection from livestock and fire, group selective cutting, and improved cutting practices. The objective of woodland management is to attain sustained production by cutting only the amount of wood that the stand is producing by growth. This cutting can be done each year or every 5 to 10 years.

Some woodlands may be of such poor quality that the best procedure is to convert them from hardwoods to the more valuable conifer species. Before such conversion, competition from inferior species of trees and shrubs must be eliminated by mowing or by spraying with a brush killer.

Soils vary in their suitability for trees. In general, the deep, well drained or moderately well drained soils of medium to high fertility are best suited to trees. The subsoil should have moderate or moderately slow permeability. These soils, however, are also well suited to cultivated crops. Trees vary in their ability to grow and develop under various soil and climatic conditions. The growth of tree roots is related to subsoil permeability. Underdeveloped roots resulting from poor aeration and poor drainage do not allow trees to develop normally above the ground.

Native hardwoods generally are not well suited to soils that have been cultivated for some time or that are eroded. Hardwoods require a site of better quality, and they grow better if planted on uncultivated soils. Pines grow better on eroded or formerly cultivated soils than hardwoods.

Woodland suitability groups

The soils of Howard County have been placed in 11 woodland suitability groups to assist owners of woodland in planning the use of their soil. Each group is made up of soils that have about the same available water capacity and other characteristics that influence growth of trees. The soils also have similar limitations and are subject to similar hazards if used for trees. All the soils in one group, therefore, support similar kinds of trees, have about the same potential productivity, and require similar kinds of management.

For most of the groups, the site index ratings are given for suitable trees. The site index, as given, is the average height, in feet, of the dominant and codominant trees in the stand at 50 years of age and is a rating of potential soil productivity (*8*). The average annual

Figure 15.—**Typical example of Sogn soils in capability unit VIIs–1.**

growth in board feet (Scribner rule) is estimated from the site index, and the kinds of trees that grow best are given for each woodland suitability group. Explanations of the terms and ratings used are given in the following paragraphs.

Plant competition refers to the rate of invasion by unwanted trees, shrubs, and vines if openings are made in the canopy. Competition is *slight* if it does not prevent adequate natural regeneration and early growth or interfere with the normal development of planted seedlings. Competition is *moderate* if it delays the establishment and slows the growth of seedlings, either naturally occurring or planted, but does not prevent the eventual development of a fully stocked, normal stand. Competition is *severe* if it prevents adequate restocking, either natural or artificial, without intensive preparation of the site and without special maintenance practices that include weeding.

Equipment limitations refer to the soil characteristics and relief features that restrict or prohibit the use of conventional equipment for planting and harvesting wood crops, for constructing roads, for controlling unwanted vegetation, and for controlling fires. The limitation is slight if there is little or no restriction on the type of equipment that can be used or the time of year that equipment can be used. The limitation is *moderate* if the use of equipment is restricted by one or more unfavorable characteristics, such as slope, stones or other obstructions, seasonal wetness, instability, or risk of injury to roots of trees. The limitation is *severe* if special equipment is needed or the use of such equipment is severely restricted by one or more unfavorable soil characteristics.

Seedling mortality refers to the expected loss of seedlings as a result of unfavorable soil characteristics or topographic features, not as a result of plant competition. Even if healthy seedlings of suitable species are correctly planted or occur naturally in adequate numbers, some will not survive if conditions are unfavorable. Ratings are based on mortality of seedlings among the number normally planted for adequate stocking. *Slight* mortality is the loss of less than 25 percent of the seedlings; *moderate*, between 25 and 50 percent; and *severe*, more than 50 percent.

Erosion hazard refers to the risk of erosion on well-managed woodland that is not protected by special practices. It is *slight* where a small loss of soil is expected. Generally, erosion is slight if slopes range from 0 to 2 percent and runoff is slow or very slow. The erosion hazard is *moderate* where there is a moderate loss of soil if runoff is not controlled and the vegetative cover is not adequate for protection. It is *severe* where steep slopes, rapid runoff, slow infiltration and permeability, and past erosion make the soil susceptible to severe erosion.

WOODLAND SUITABILITY GROUP 1

This group consists of somewhat excessively drained and excessively drained soils that are shallow to sandy and gravelly material and to bedrock. These soils are of the Burkhardt, Lilah, and Sogn series. Available water capacity is very low; and permeability ranges from rapid to very rapid, except in the Sogn soils, where it is moderate. Slopes range from 1 to 40 percent. The nearly level to strongly sloping Burkhardt and Lilah soils are on stream benches and uplands throughout the county; the gently sloping to steep Sogn soils are on uplands.

These soils are poorly suited to upland hardwoods and fairly suited to conifers. Trees to favor in existing stands are hackberry, red oak, and white oak. Bur oak survives well, but it does not produce as much wood on these soils as on the soils in other places. The average site index for upland hardwoods is less than 45. Estimated annual timber production per acre is less than 100 feet.

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*

[Dashes indicate the soil is not suited to the crop or that the crop is not ordinarily grown]

Soil	Corn		Soybeans		Oats		Hay		Pasture	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*A.U.D.*[1]	*A.U.D.*[1]
Ankeny sandy loam, 0 to 2 percent slopes	70	90	26	34	50	65	2.0	3.5	100	175
Backbone fine sandy loam, 2 to 5 percent slopes	50	65	19	25	35	45	1.2	2.2	60	110
Backbone fine sandy loam, 5 to 9 percent slopes	40	50	15	19	28	35	1.0	2.0	50	100
Bassett loam, 0 to 2 percent slopes	85	110	32	42	60	75	3.0	4.5	150	225
Bassett loam, 2 to 5 percent slopes	80	105	30	40	55	73	3.0	4.5	150	225
Bassett loam, 5 to 9 percent slopes	75	100	28	38	50	70	2.5	4.0	125	200
Bassett loam, 5 to 9 percent slopes, moderately eroded	70	95	26	36	45	65	2.0	3.8	100	190
Burkhardt sandy loam, 3 to 9 percent slopes	35	45	12	17	25	30	.5	1.5	25	100
Clyde silty clay loam	75	100	28	38	50	70	2.0	4.0	100	200
Clyde-Floyd complex, 1 to 4 percent slopes	80	105	30	40	55	73	2.5	4.0	125	200
Coggon loam, 2 to 5 percent slopes	75	100	28	38	50	70	2.5	4.5	125	230
Colo silty clay loam, loamy substratum	85	105	32	40	60	73	3.5	5.0	175	250
Colo-Alluvial land complex	60	75	20	26	40	55	2.0	3.0	100	150
Colo-Alluvial land complex, channeled	---	---	---	---	---	---	---	---	100	120
Cresco loam, 2 to 5 percent slopes	70	90	26	34	50	65	2.5	4.0	125	200
Cresco loam, 5 to 9 percent slopes	65	85	25	32	45	60	2.2	4.0	110	200
Dickinson fine sandy loam, 0 to 2 percent slopes	65	85	25	32	45	60	1.5	3.0	75	150
Dickinson fine sandy loam, 2 to 5 percent slopes	60	80	23	30	42	55	1.5	3.0	75	150
Dickinson-Ostrander complex, 2 to 5 percent slopes	75	100	28	38	50	70	2.0	3.5	100	175
Dickinson-Racine complex, 2 to 5 percent slopes	70	95	26	36	45	65	2.0	3.5	100	175
Donnan loam, 0 to 2 percent slopes	65	85	25	32	45	60	2.0	3.5	100	175
Donnan loam, 2 to 5 percent slopes	60	80	23	30	42	55	1.5	3.0	75	150
Downs silt loam, 2 to 5 percent slopes	90	120	34	45	65	85	4.0	5.0	200	250
Downs silt loam, 5 to 9 percent slopes	85	115	32	43	60	80	4.0	5.0	200	250
Downs silt loam, 5 to 9 percent slopes, moderately eroded	80	110	30	41	55	75	3.5	4.5	175	230
Downs silt loam, 9 to 14 percent slopes, moderately eroded	75	100	28	38	50	70	3.0	4.0	150	200
Downs silt loam, 14 to 20 percent slopes, moderately eroded	70	90	26	34	50	65	2.5	3.5	125	175
Fayette silt loam, 5 to 9 percent slopes	80	110	30	41	55	75	3.5	4.5	175	230
Fayette silt loam, 9 to 14 percent slopes	75	100	28	38	50	70	3.0	4.0	150	200
Fayette silt loam, 14 to 20 percent slopes	70	90	26	34	50	65	2.5	3.5	125	175
Fayette silt loam, 20 to 30 percent slopes	---	---	---	---	---	---	2.0	3.0	100	150
Floyd loam, 1 to 4 percent slopes	80	110	30	41	55	75	3.0	4.5	150	230
Hayfield loam, moderately deep	65	85	25	32	45	60	2.5	3.5	125	175
Hayfield loam, deep	75	100	28	38	50	70	3.0	4.0	150	200
Jacwin silty clay, 0 to 2 percent slopes	70	90	26	34	50	65	2.0	3.5	100	175
Jameston silty clay loam	60	80	23	30	45	65	1.5	3.0	75	150
Kenyon loam, 2 to 5 percent slopes	85	115	32	45	60	80	3.0	4.5	150	230
Kenyon loam, 5 to 9 percent slopes	80	110	30	41	55	75	3.0	4.5	150	230
Kenyon loam, 5 to 9 percent slopes, moderately eroded	75	105	28	40	50	73	2.5	4.0	125	200
Lamont fine sandy loam, 0 to 2 percent slopes	60	75	22	28	40	50	1.5	3.0	75	150
Lamont fine sandy loam, 2 to 5 percent slopes	55	70	19	27	35	50	1.5	3.0	75	150
Lamont fine sandy loam, 5 to 9 percent slopes	50	65	18	25	35	45	1.0	2.5	50	125
Lawler loam, moderately deep	70	90	26	34	50	65	3.0	4.0	150	200
Lawler loam, deep	80	105	30	40	55	73	3.5	4.5	175	230
Lilah sandy loam, 0 to 3 percent slopes	35	45	12	17	25	30	.5	2.0	25	100
Lilah sandy loam, 3 to 9 percent slopes	30	40	11	15	20	25	.5	1.5	25	75
Lilah sandy loam, 9 to 14 percent slopes	---	---	---	---	---	---	.5	1.0	25	50
Lourdes loam, 2 to 5 percent slopes	65	85	25	32	45	60	2.5	4.0	125	200
Lourdes loam, 5 to 9 percent slopes	60	80	23	30	42	55	2.0	3.5	100	175
Marsh	---	---	---	---	---	---	---	---	---	---
Marshan clay loam, deep	75	100	28	38	50	70	3.0	4.0	150	200
Marshan clay loam, depressional	50	70	19	27	35	50	2.0	3.0	100	150
Muck, shallow	55	75	19	28	35	50	---	---	---	---
Muck, moderately deep	45	65	17	25	30	45	---	---	---	---
Muck, deep	45	65	17	25	30	45	---	---	---	---
Oran loam, 0 to 2 percent slopes	80	105	30	40	55	73	3.0	4.5	150	230
Oran loam, 2 to 5 percent slopes	75	100	28	38	50	70	2.5	4.0	125	200
Ostrander loam, 0 to 2 percent slopes	90	120	34	45	65	85	4.0	5.0	200	250
Ostrander loam, 2 to 5 percent slopes	85	115	32	43	60	80	3.5	5.0	175	250
Ostrander loam, 5 to 9 percent slopes	80	110	30	41	55	75	3.0	4.5	150	230
Ostrander loam, 5 to 9 percent slopes, moderately eroded	75	105	28	40	50	73	2.5	4.0	125	200
Pinicon silt loam, 1 to 4 percent slopes	70	95	26	36	45	65	2.5	3.5	125	175
Port Byron silt loam, 2 to 5 percent slopes	95	125	36	47	65	85	4.0	5.2	200	260
Protivin loam, 1 to 4 percent slopes	70	90	26	34	50	65	3.0	4.0	150	200
Racine loam, 0 to 2 percent slopes	85	115	32	43	60	80	3.0	4.5	150	230
Racine loam, 2 to 5 percent slopes	80	110	30	41	55	75	2.8	4.5	140	230
Racine loam, 5 to 9 percent slopes	75	105	28	40	50	73	2.5	4.0	125	200

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*—Continued

Soil	Corn		Soybeans		Oats		Hay		Pasture	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*A.U.D.*[1]	*A.U.D*[1]
Racine loam, 5 to 9 percent slopes, moderately eroded	75	100	28	38	50	70	2.2	3.8	110	190
Radford silt loam	85	115	32	43	60	80	4.0	4.5	200	230
Radford and Huntsville silt loams, 2 to 5 percent slopes	90	120	34	45	65	85	4.0	4.5	200	230
Readlyn loam, 0 to 2 percent slopes	85	115	32	43	60	80	3.5	4.5	175	230
Readlyn loam, 2 to 5 percent slopes	80	110	30	41	55	75	3.5	4.5	175	230
Renova loam, 2 to 5 percent slopes	80	105	30	40	55	73	2.8	4.0	140	200
Riceville loam, 1 to 4 percent slopes	65	85	25	32	45	60	2.0	4.0	100	200
Rockton loam, moderately deep, 0 to 2 percent slopes	60	80	23	30	40	55	2.5	3.5	125	175
Rockton loam, moderately deep, 2 to 5 percent slopes	55	75	19	28	35	50	2.5	3.5	125	175
Rockton loam, moderately deep, 5 to 9 percent slopes	50	70	19	27	35	50	2.0	3.0	100	150
Rockton loam, moderately deep, 5 to 9 percent slopes, moderately eroded	45	65	17	25	30	45	1.5	2.5	75	125
Rockton loam, deep, 0 to 2 percent slopes	75	100	28	38	50	70	3.5	4.5	175	230
Rockton loam, deep, 2 to 5 percent slopes	70	95	26	36	45	65	3.5	4.5	175	230
Rockton loam, deep, 5 to 9 percent slopes	65	90	25	34	42	65	3.0	4.0	150	200
Sattre loam, 0 to 2 percent slopes	70	95	26	36	45	65	2.5	4.0	125	200
Saude loam, 0 to 2 percent slopes	65	85	25	32	45	60	2.5	3.5	125	175
Saude loam, 2 to 5 percent slopes	60	80	23	30	40	55	2.5	3.5	125	175
Saude sandy loam, 0 to 2 percent slopes	55	75	19	28	35	50	2.0	3.0	100	150
Saude sandy loam, 2 to 5 percent slopes	50	70	18	27	35	50	2.0	3.0	100	150
Schley silt loam, 1 to 4 percent slopes	75	100	28	38	50	70	2.5	4.0	125	200
Sogn loam, 2 to 5 percent slopes	35	50	13	19	25	35	.5	1.5	25	75
Sogn loam, 5 to 14 percent slopes	------	------	------	------	------	------	.5	1.5	25	75
Sogn loam, 14 to 40 percent slopes	------	------	------	------	------	------	.5	1.0	25	50
Sparta loamy fine sand, 0 to 2 percent slopes	55	70	19	27	35	50	1.5	3.0	75	150
Sparta loamy fine sand, 2 to 5 percent slopes	50	65	18	25	35	45	1.5	3.0	75	150
Sparta loamy fine sand, 5 to 9 percent slopes	40	55	15	21	28	40	1.0	2.0	50	100
Spillville loam	90	120	34	45	65	85	3.5	4.5	175	230
Spillville-Colo complex	80	110	30	41	55	75	3.5	4.5	175	230
Spillville-Colo complex, channeled	------	------	------	------	------	------	------	------	100	120
Terril loam, 0 to 2 percent slopes	95	125	36	47	70	90	3.5	5.0	175	250
Terril loam, 2 to 5 percent slopes	90	120	34	35	65	85	3.5	5.0	175	250
Tripoli silty clay loam	80	110	30	41	55	75	3.0	4.5	150	230
Turlin silt loam, acid variant	90	120	34	45	65	85	3.5	4.5	175	230
Wapsie loam, 0 to 2 percent slopes	60	80	23	30	40	55	2.0	3.5	100	175
Wapsie loam, 2 to 5 percent slopes	55	75	19	28	35	50	2.0	3.5	100	175
Wapsie loam, 5 to 9 percent slopes	45	65	17	25	30	45	1.5	3.0	75	150
Waukee loam, 0 to 2 percent slopes	75	100	28	38	55	70	3.0	4.5	150	230
Waukee loam, 2 to 5 percent slopes	70	95	26	36	50	65	3.0	4.5	150	230
Whalan loam, moderately deep, 2 to 5 percent slopes	45	65	17	25	30	45	1.5	3.0	75	150
Whalan loam, moderately deep, 5 to 9 percent slopes	40	60	15	22	28	40	1.0	2.5	50	125
Winneshiek loam, deep, 0 to 2 percent slopes	70	95	26	36	50	65	3.0	4.5	150	230
Winneshiek loam, deep, 2 to 5 percent slopes	65	90	25	34	45	60	3.0	4.5	150	230
Winneshiek loam, deep, 5 to 9 percent slopes	60	85	23	32	40	60	2.5	4.0	125	200
Winneshiek loam, moderately deep, 0 to 2 percent slopes	55	75	19	28	35	50	2.5	3.5	125	175
Winneshiek loam, moderately deep, 2 to 5 percent slopes	50	70	18	27	35	50	2.5	3.5	125	175
Winneshiek loam, moderately deep, 5 to 9 percent slopes	45	65	17	25	30	45	2.0	3.0	100	150
Winneshiek loam, moderately deep, 5 to 9 percent slopes, moderately eroded	40	60	15	22	28	40	1.5	3.0	75	150
Winneshiek loam, moderately deep, 9 to 14 percent slopes	40	60	14	20	25	40	1.5	2.8	75	140
Winneshiek loam, shaly subsoil variant, 0 to 2 percent slopes	55	75	19	28	35	50	2.5	4.0	125	200

[1] Animal-unit-days (A.U.D.) is the number of animal units carried per acre multiplied by the number of days the pasture is grazed during a single season without injury to the sod. Animal-unit-days for an improved pasture is based on the assumption that one mature animal will consume 40 pounds of dry matter per acre per year. Yields are based on alfalfa and grass mixtures, but where no hay yields are given, yields are based on permanent bluegrass pasture.

Seedling mortality on these soils is slight to severe, depending on the amount of competiton from grass and the variation of moisture supply. Equipment limitations are slight where slope is 0 to 18 percent and moderate to severe where slope is more than 18 percent. The hazard of erosion is slight to severe, depending on slope.

Trees suitable for windbreaks are eastern white pine, Scotch pine, red pine, eastern redcedar, and jack pine. Species suitable for wildlife plantings are honeysuckle, ninebark, and Russian-olive.

WOODLAND SUITABILITY GROUP 2

Only the Sparta soils are in this group. These soils are excessively drained, coarse textured, and rapidly permeable. Available water capacity is very low. Slopes range from 0 to 9 percent. These soils are throughout the county.

Sparta soils are fairly well suited to hardwoods. They are suited to conifers and cottonwoods. Trees to favor in existing stands are red oak, white oak, green ash, hackberry, and cottonwood. The average site index for upland

hardwoods ranges from 46 to 55. Estimated annual production per acre from the existing trees ranges from 100 to 150 board feet.

Seedling mortality generally is slight, but it is severe during periods of drought. Plant competition from grass or weeds or undesirable species is slight to moderate. The hazard of erosion is slight to severe, depending on slope.

Trees most suitable for windbreaks are eastern white pine, red pine, Scotch pine, eastern redcedar, jack pine, Norway poplar, Siouxland poplar, robusta poplar, green ash, and hackberry. Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and Russian-olive.

WOODLAND SUITABILITY GROUP 3

This group consists of well-drained to somewhat excessively drained soils that are moderately coarse textured throughout and of soils that are medium-textured to moderately fine textured in the upper part and that have sand, gravelly sand, or bedrock at a depth of 20 to 40 inches. These are the Dickinson, Lamont, Ostrander, Racine, Saude, and Wapsie soils, which are underlain by sandy material; and the Backbone soils and moderately deep Rockton, Whalan, and Winneshiek soils, which are underlain by limestone bedrock. These soils are on benches and uplands. Slopes range from 0 to 14 percent. Permeability is moderate to moderately rapid, and available water capacity is moderately low. The principal limitation to the growth of trees is inadequate moisture supply.

Suitability of these soils for hardwoods is good, and for conifers is very good. Trees to favor in existing stands are red oak, white oak, green ash, black walnut, basswood, butternut, hackberry, and hard maple.

The average site index for upland hardwoods ranges from 56 to 65. Estimated annual production per acre from the existing trees ranges from 150 to 200 board feet. Seedling mortality is generally slight. Plant competition from grass or weeds or undesirable species is slight to moderate. The hazard of erosion ranges from slight to severe, depending on slope.

WOODLAND SUITABILITY GROUP 4

This group consists of well-drained, medium-textured to moderately fine textured soils on uplands. These soils of the Downs, Fayette, and Port Byron series. They are moderately permeable, and available water capacity is high. These soils are gently sloping to rolling, and slopes range from 2 to 20 percent.

Suitability of these soils for hardwoods is excellent. Trees to favor in existing hardwood stands are walnut, white oak, red oak, green ash, hard maple, butternut, basswood, and wild blackcherry. Estimated suitability of these soils for conifers and cottonwood is excellent.

The measured average site index for upland hardwoods ranges from 76 to 85. Estimated annual production per acre from existing trees in well-managed and fully stocked stands ranges from 250 to more than 300 board feet. Seedling mortality is generally slight. Plant competition from grass or weeds or undesirable species is slight to severe. The hazard of erosion is slight to moderate.

Trees suitable for open-land plantings are eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, walnut, green ash, hackberry, and hard maple. Trees suitable for windbreaks are eastern white pine, red pine, eastern redcedar, Norway spruce, white spruce, Norway poplar, Siouxland poplar, robusta poplar, green ash, and hackberry. Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and Russian-olive.

WOODLAND SUITABILITY GROUP 5

Only Fayette silt loam, 20 to 30 percent slopes, is in this group. This soil is a well-drained, medium-textured to moderately fine textured soil on uplands. It is moderately permeable and has high available water capacity. The relief is rolling. In cultivated areas surface runoff is rapid.

Nearly all of this soil is in trees, some of which are of low quality. Trees to favor in existing stands are black walnut, white oak, red oak, green ash, hard maple, basswood, and wild blackcherry.

The suitability of this soil for trees where slopes face north and east is very good for hardwoods and very good to excellent for conifers. Where slopes face south and west, suitability is good for hardwoods and good to very good for conifers. The site index for upland hardwoods on the slopes that face north and east ranges from 66 to 75. The estimated annual production per acre from existing trees in well-managed and fully stocked stands ranges from 200 to 249 board feet. Where slopes face south and west, the index ranges from 56 to 65, and the annual production per acre ranges from 150 to 159 board feet. Seedling mortality is generally slight. Plant competition from grass, weeds, or undesirable species is moderate. The hazard of erosion is severe.

Trees suitable for upland plantings are eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, walnut, green ash, hackberry, and hard maple. Trees suitable for windbreaks are eastern white pine, red pine, Norway spruce, white spruce, Eastern redcedar, Norway poplar, Siouxland poplar, robusta poplar, green ash, and hackberry. Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, and dogwood.

WOODLAND SUITABILITY GROUP 6

This group consists of well drained and moderately well drained, medium-textured soils on uplands. These are the Bassett, Coggon, Kenyon, Ostrander, Racine, Renova, Rockton, Sattre, Waukee, and Winneshiek soils on the tops and sides of ridges and the Terril soils in drainageways and on lower foot slopes. These soils have moderate to moderately slow permeability and moderate to high available water capacity. Slopes range from 0 to 9 percent.

The suitability of these soils is good to very good for hardwoods, good for conifers, and very good for cottonwoods. Trees to favor in existing stands are red oak, white oak, green ash, black walnut, butternut, basswood, hackberry, hard maple, and soft maple. The average index for upland hardwoods ranges from 66 to 75. Estimated annual production per acre of existing trees on these soils ranges from 200 to 250 board feet. Seedling mortality is generally slight. Plant competition from grass, weeds, or undesirable species is slight to moderate. The hazard of erosion is slight.

Trees suitable for plantings in open areas are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut, green ash, and hackberry. Trees suitable for windbreaks are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, Douglas-fir, Norway poplar, Siouxland poplar, robusta poplar, green ash, and hackberry. Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, and dogwood.

WOODLAND SUITABILITY GROUP 7

This group consists of moderately well drained and somewhat poorly drained, moderately fine textured and fine textured soils on uplands. These are soils of the Cresco, Donnan, Jacwin, Lourdes, Protivin, and Riceville series and of the Winneshiek series, shaly subsoil variant. Permeability in these soils is slow and very slow. Available water capacity generally is high but it is moderate in the Winneshiek soils. The principal limitations are slow permeability and wetness. Slopes range from 0 to 9 percent.

The suitability of the soils for production of wood crops is fair. Trees to favor in existing stands are green ash, hackberry, cottonwood, and soft maple. The average site index for upland hardwoods ranges from 46 to 55. Estimated annual production per acre from existing trees ranges from 100 to 200 board feet. Seedling mortality is generally slight. Plant competition from grass or weeds or undesirable species is slight to moderate.

Trees suitable for open-land plantings are eastern white pine, Scotch pine, eastern redcedar, Norway spruce, black walnut, green ash, hackberry, and hard maple. Trees suitable for windbreaks are eastern white pine, Scotch pine, eastern redcedar, and Norway spruce, green ash, hackberry, cottonwood, and willow. Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and Russian-olive.

WOODLAND SUITABILITY GROUP 8

This group consists of somewhat poorly drained, medium-textured soils on benches and uplands. These are soils of the Floyd, Oran, Pinicon, Readlyn, and Schley series on uplands, and the Hayfield and Lawler series on benches. Slopes range from 0 to 5 percent. Permeability in these soils, except for the Hayfield and Lawler soils, is moderate to moderately slow. Permeability is rapid or very rapid in the substratum of the Hayfield and Lawler soils. Available water capacity is low to high in all the soils in this group. The principal limitation to growth of trees on these soils is wetness.

Suitability of these soils for hardwoods and conifers is good, and for cottonwoods it is very good. Trees to favor in existing stands are green ash, hackberry, white oak, red oak, and cottonwood. The average site index for hardwood ranges from 56 to 65. Estimated annual production per acre ranges from 150 to 200 board feet. Seedling mortality is generally slight. Plant competition from undesirable species is moderate. Erosion is a slight hazard on the gently sloping soils.

Trees suitable for open-land plantings are eastern white pine, Scotch pine, red pine, Norway spruce, eastern redcedar, European larch, green ash, walnut, and hackberry. Trees suitable for windbreak and wildlife plantings are eastern white pine, Scotch pine, red pine, Norway spruce, eastern redcedar, Norway poplar, Siouxland poplar, robusta poplar, green ash, soft maple, willow, and hackberry. Suitable shrubs are honeysuckle and red-osier dogwood.

WOODLAND SUITABILITY GROUP 9

This group consists of deep, somewhat excessively drained to somewhat poorly drained, moderately coarse textured to medium-textured soils. These soils are nearly level on bottom lands and gently sloping on a few upland waterways. These are soils of the Ankeny, Colo, Huntsville, Radford, and Spillville series, of the Turlin series, acid variant. Slopes range from 0 to 5 percent. These soils are subject to some flooding. Runoff is slow on the level soils. Permeability is moderately rapid in the Ankeny soils and moderate in the rest. The available water capacity is moderate to low in Ankeny soils and high in the other soils.

Suitability of these soils for bottom-land hardwoods is high. Estimated annual production per acre of bottom-land hardwoods ranges from 300 to 700 board feet. Seedling mortality is generally slight. Plant competition from undesirable species is moderate to severe, depending on the population of weeds. Erosion is a hazard on the gently sloping Radford and Huntsville soils.

Trees suitable for production of wood crops are cottonwood, soft maple, hackberry, and green ash. These species and willow are suitable for windbreak plantings. These soils are not well suited to upland hardwoods or conifers.

WOODLAND SUITABILITY GROUP 10

This group consists of somewhat poorly drained and poorly drained, moderately fine textured soils on uplands, benches, and bottom lands. These soils are of the Clyde, Floyd, Colo, Jameston, Marshan, and Triopoli series. Areas of Alluvial land are also in this group. Permeability is moderate in the Clyde, Floyd, and Marshan soils; moderately slow in the Colo and Tripoli soils; and slow in the Jameston soils. Most of the soils have high available water capacity, but Alluvial land has properties that are too variable to evaluate. The Colo soils are subject to frequent flooding; Marshan soils are flooded occasionally; and the Clyde, Floyd, Jameston, and Tripoli soils receive local runoff. Slopes are 0 to 4 percent.

Suitability of these soils for production of commercial wood crops is fair to poor. Suitable trees are soft maple, cottonwood, sycamore, willow, green ash, and hackberry. Less suitable are redcedar, eastern white pine, Scotch pine, Norway spruce, and European larch. These conifers are mainly suited to the soils on uplands and second bottoms that are not subject to flooding.

WOODLAND SUITABILITY GROUP 11

This group consists of the very poorly drained Mucks and Marsh, which are scattered throughout the county. Suitability of these soils for production of commercial wood crops is very low. Trees best suited are cottonwood and willow. Species suitable for wildlife plantings include red-osier dogwood and buttonball bush.

Engineering Uses of the Soils [3]

For many years engineers have studied soil properties and characteristics that affect construction and have devised systems of soil classification based on these characteristics. Most of these studies have been at the site of construction, because general information about the soils of an area has not been readily available.

With a soil map for identification, the interpretations reported here will be useful in engineering planning. It is emphasized, however, that additional sampling and testing for specific engineering works may be needed, especially where heavy loads and deep excavations are involved. But in nearly all situations, the soil map is useful for planning the additional investigations, because it suggests the kinds of problems that may be expected in a given area.

At many construction sites, major differences occur in a soil within the depth of a proposed excavation, and several kinds of soil can occur within short distances. The soil engineer can concentrate on the major soil units by referring to this survey. He can then determine the minimum number of samples needed for further laboratory testing and can make adequate investigations at minimum cost.

The information in this section can be helpful to those who—

1. Make studies of soil and land use that will aid in the selection and development of industrial, business, residential, and recreational sites.
2. Plan and design drainage and irrigation structures and all structural work for soil and water conservation.
3. Make general surveys of soil and ground conditions that will aid in selecting highway and airport locations, and in planning more detailed soil surveys for these locations if needed.
4. Locate probable sources of sand, gravel, or rock for structural use.
5. Correlate the performance of pavement and road rock with kinds of soils, and thus develop information useful in the construction and maintenance of roads, culverts, and bridges.
6. Determine the suitability of soils for cross-country movement of heavy equipment.
7. Supplement information obtained from aerial photographs, other published reports, and miscellaneous soil information obtained from other sources.

Most of the information in this section is presented in tables 3, 4, and 5, which show, respectively, estimates of several soil properties significant in engineering; interpretations for various engineering uses; and results of engineering laboratory tests conducted on soil samples.

Some terms used in this soil survey have special meaning to soil scientists that is not known to all engineers. Many of the terms used in soil science are defined in the Glossary.

[3] DONALD A. ANDERSON, soil engineer, Iowa State Highway Commission, helped to prepare the engineering tables.

Engineering classification systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (AASHO) (*1*). In this system soil materials are classified in seven principal groups. These groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, which is made up of fine textured, clayey soils that have low strength when wet. The best soils for subgrade are in group A–1, the poorest in A–7.

Some engineers prefer to use the Unified soil classification system (*11*). In this system, soil materials are identified as coarse-grained (GW, GP, GM, GC, SW, SP, SM, and SC), fine-grained (ML, CL, OL, MH, CH, and OH), or highly organic (Pt). Approximate classification can be made in the field. Estimated classification of the soils in Howard County is given in table 3.

Soil engineering data and interpretations

The data in table 3 are based on the test data in table 5, on information in other parts of the survey, and on experience with similar soils in other counties. Table 5 presents laboratory test data for samples taken from selected soil profiles in Howard County. Additional information can be obtained from other parts of the survey, especially from the sections "General Soil Map," "Descriptions of the Soils," and "Formation and Classification of the Soils."

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

The *percentage passing sieves* is the normal range of soil particles passing the respective screen sizes.

Permeability refers to the rate of movement of water through undisturbed soil. Permeability depends largely on the soil texture and structure.

Available water capacity is the amount of water in a moist soil, at field capacity, that can be removed by plants. These ratings, expressed in inches of water per inch of soil depth, are of particular value to engineers in irrigation.

Reaction is the degree of acidity or alkalinity of a soil, expressed as pH. The pH value and terms used elsewhere in this survey to describe soil reaction are explained in the Glossary.

Shrink-swell potential is a rating of the ability of soil material to change volume when subjected to changes in moisture. Those soil materials rated high are normally undesirable from the engineering standpoint, because the increase in volume when the dry soil is moistened generally is accompanied by a loss in bearing capacity. In general, soils classed as CH and A–7 have high shrink-swell potential. Clean sand and gravel (single-grain structure) and soils containing a small amount of nonplastic to slight plastic fines have low shrink-swell potential.

Interpretations of engineering properties of the soils are given in table 4. In this table are estimates of the suitability of the soils of the county as a source of topsoil, sand, gravel, limestone, and road fill. Also in the table are estimates of soil features affecting suitability of the soils for various engineering purposes.

TABLE 3.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. These soils appear in the first column. The symbol <

Soil series and map symbols	Depth to— Limestone bedrock	Depth to— Seasonal high water table	Depth from surface (typical profile)	Classification USDA texture
	Feet	*Feet*	*Inches*	
Alluvial land. Mapped only in complexes with Colo soils in units 715 and 315. Properties are too variable to be estimated.				
Ankeny: 136A	>10	>5	0–23	Sandy loam
			23–44	Sandy loam
			44–72	Loamy sand and sand
Backbone: 109B, 109C	2–3	>5	0–22	Fine sandy loam to sandy loam
			22–35	Sandy loam to light sandy clay loam.
			>35	Limestone bedrock.
Bassett: 171A, 171B, 171C, 171C2	>10	[1] 1½–2	0–14	Loam
			14–43	Heavy loam
			43–67	Heavy loam
Burkhardt: 285C	>10	>5	0–16	Sandy loam
			16–44	Gravelly loamy sand and sand
			44–72	Coarse sand
*Clyde: 84, 391B. For properties of the Floyd part of 391B, see Floyd series.	>10	1–2	0–24	Silty clay loam
			24–41	Silty clay loam and loam
			41–66	Heavy loam
Coggon: 302B	>10	[1] 1½–2	0–16	Loam
			16–42	Heavy loam
			42–75	Heavy loam
Colo: 133, 315, 715	>10	1½–3	0–38	Silty clay loam
			38–72	Stratified loam, loamy sand, and sandy loam.
Cresco: 783B, 783C	>10	([1])	0–13	Heavy loam
			13–25	Heavy loam
			25–40	Medium clay loam
			40–60	Medium to light clay loam
*Dickinson: 175A, 175B, 575B, 576B. For properties of the Ostrander part of 575B and the Racine part of 576B, see Ostrander and Racine series, respectively.	>10	>5	0–36	Fine sandy loam
			36–72	Loamy fine sand and sand
Donnan: 782A, 782B	>10	([1])	0–17	Loam
			17–31	Sandy loam and loam
			31–57	Silty clay to heavy silty clay loam.
			57–92	Loam
Downs: 162B, 162C, 162C2, 162D2, 162E2	>10	>5	0–7	Silt loam
			7–24	Silty clay loam
			24–61	Silt loam

See footnotes at end of table.

significant in engineering

may have different properties and limitations. Therefore it is necessary to follow carefully the instructions for referring to other series that means less than; the symbol > means greater than]

Classification—Continued		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
SM or SC	A-4	----------	100	35-50	2. 0-6. 3	0. 11-0. 16	5. 6-6. 0	Low.
SM	A-4 or A-2-4	----------	100	25-45	2. 0-6. 3	0. 10-0. 14	5. 6-6. 5	Low.
SM	A-2-4	100	95-100	10-20	6. 3-20. 0	0. 03-0. 06	6. 1-6. 5	Very low or none.
SM	A-2-4 or A-4	----------	100	30-45	2. 0-6. 3	0. 08-0. 13	6. 1-6. 5	Low.
SC or CL	A-4 (1-4) or A-6 (4)	----------	100	35-55	2. 0-6. 3	0. 10-0. 17	6. 1-7. 8	Low.
CL	A-6 (4-8)	----------	100	65-80	0. 63-2. 0	0. 15-0. 18	4. 5-6. 5	Moderate.
CL	A-6 (6-10)	95-100	90-95	50-65	0. 20-0. 63	0. 14-0. 17	4. 5-6. 5	Moderate.
CL	A-6 (6-10)	95-100	90-95	50-65	0. 20-0. 63	0. 14-0. 17	6. 1-7. 3	Moderate.
SM	A-2-4 or A-4	90-100	90-95	25-40	>20. 0	0. 09-0. 11	4. 5-5. 5	Low.
SM-SW or SW	A-1-b	70-90	60-80	3-15	>20. 0	0. 02-0. 04	5. 6-6. 0	None.
SW or SM-SW	A-1-b or A-2-4	70-95	60-95	3-10	>20. 0	0. 02-0. 04	5. 6-6. 0	None.
ML, CL, or MH	A-7-5 or A-7-6 (11-18)	----------	100	70-90	0. 63-2. 0	0. 19-0. 22	6. 6-7. 3	High.
CL	A-7-6(8-12) or A-6(6-10)	95-100	90-100	50-65	0. 63-2. 0	0. 15-0. 18	6. 6-7. 3	Moderate.
CL	A-6(6-10)	95-100	90-100	50-65	0. 63-2. 0	0. 14-0. 17	6. 6-7. 8	Moderate.
ML or CL	A-4(6-8) or A-6(6-10)	----------	100	65-80	0. 63-2. 0	0. 14-0. 18	4. 5-5. 5	Moderate.
CL	A-6(8-12)	95-100	90-100	50-65	0. 20-0. 63	0. 14-0. 17	5. 1-5. 5	Moderate.
CL	A-6(8-12)	95-100	90-100	50-65	0. 20-0. 63	0. 14-0. 17	5. 6-7. 8	Moderate.
CL or MH	A-7-6(11-18)	----------	100	80-100	0. 20-0. 63	0. 16-0. 21	6. 1-7. 3	High.
CL or SM	A-6(4-8) and A-2-4 or A-3	100	90-100	20-60	0. 63-6. 3	0. 08-0. 14	6. 6-7. 3	Low or moderate.
OL or CL	A-7-5(8-12)	100	100	65-80	0. 63-2. 0	0. 17-0. 19	5. 1-7. 3	Moderate.
CL	A-6(6-10)	100	95-100	50-65	0. 63-2. 0	0. 14-0. 17	5. 1-5. 5	Moderate.
CL	A-6(8-12)	100	95-100	60-70	0. 06-0. 2	0. 15-0. 18	5. 1-5. 5	Moderate.
CL	A-6(8-12)	100	95-100	60-70	0. 06-0. 2	0. 15-0. 18	6. 6-7. 8	Moderate.
SM or SC	A-4 or A-2	100	100	35-50	2. 0-6. 3	0. 11-0. 16	5. 1-7. 3	Low.
SM	A-2-4 or A-3	100	100	10-20	6. 3-20. 0	0. 03-0. 06	5. 1-5. 5	Very low or none.
CL	A-6(6-10)	100	100	55-75	0. 63-2. 0	0. 15-0. 19	4. 5-5. 5	Moderate.
SM and CL	A-4 or A-6(4-8)	95-100	95-100	35-65	2. 0-6. 3	0. 08-0. 13	4. 5-5. 0	Low.
CH	A-7-6(16-20)	95-100	95-100	70-90	<0. 06	0. 15-0. 18	4. 5-6. 5	High.
CL	A-6(6-12)	95-100	95-100	50-65	0. 20-0. 63	0. 14-0. 17	6. 6-7. 3	Moderate.
ML	A-4(6-8)	100	100	95-100	0. 63-2. 0	0. 18-0. 22	6. 6-7. 3	Moderate.
CL	A-7-6(10-12)	100	100	95-100	0. 63-2. 0	0. 19-0. 21	4. 5-6. 5	Moderate to high.
ML or CL	A-6(6-10) or A-7-6(10-12)	100	100	95-100	0. 63-2. 0	0. 18-0. 21	4. 5-6. 0	Moderate.

TABLE 3.—*Estimated soil properties*

Soil series and map symbols	Depth to— Limestone bedrock	Depth to— Seasonal high water table	Depth from surface (typical profile)	Classification — USDA texture
	Feet	*Feet*	*Inches*	
Fayette: 163C, 163D, 163E, 163F	>10	>5	0–20	Silt loam
			20–43	Silty clay loam
			43–78	Silt loam
Floyd: 198B	>10	1½–2	0–19	Heavy loam
			19–34	Stratified loam and sandy loam
			34–78	Heavy loam
Hayfield:				
725	>10	2–3	0–14	Loam
			14–27	Loam
			27–60	Sand or gravelly sand
726	>10	2–3	0–14	Loam
			14–36	Loam
			36–60	Gravelly loamy sand
Huntsville	>10	>5	0–27	Silt loam
Mapped only in a complex with Radford soil.			27–73	Silt loam
Jacwin: 444	5–10	1½–2½	0–15	Silty clay loam
			15–22	Clay loam
			22–44	Silty clay
Jameston: 797	>10	1–2	0–22	Silty clay loam
			22–42	Loam and clay loam
			42–82	Light to medium clay loam
Kenyon: 83B, 83C, 83C2	>10	(1)	0–16	Loam
			16–43	Heavy loam
			43–71	Heavy loam
Lamont: 110A, 110B, 110C	>10	>5	0–14	Fine sandy loam
			14–29	Sandy loam
			29–70	Loamy sand and sandy loam
Lawler:				
225	>10	2–3	0–18	Heavy loam
			18–27	Loam
			27–60	Sand or gravelly sand
226	>10	2–3	0–19	Heavy loam
			19–37	Loam to sandy clay loam
			37–60	Gravelly loamy sand
Lilah: 776A, 776C, 776D	>10	>5	0–15	Sandy loam
			15–39	Gravelly loamy sand and sand
			39–100	Loamy sand
Lourdes: 781B, 781C	>10	(1)	0–11	Heavy loam
			11–18	Heavy loam
			18–44	Clay loam
			44–76	Clay loam

See footnotes at end of table.

significant in engineering—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
ML	A-4(6-8)	100	100	95-100	0. 63-2. 0	0. 18-0. 21	5. 1-6. 0	Moderate.
CL	A-7-6(10-14)	100	100	95-100	0. 63-2. 0	0. 19-0. 21	5. 1-5. 5	Moderate to high.
ML or CL	A-6(6-10) or A-7-6(10-12)	100	100	95-100	0. 63-2. 0	0. 18-0. 21	5. 1-6. 0	Moderate.
OH or CL	A-7-5(10-16)	100	100	70-85	0. 63-2. 0	0. 19-0. 20	6. 1-7. 3	Moderate to high.
SM or SC	A-2-4 or A-4	80-100	75-95	20-50	0. 63-2. 0	0. 13-0. 17	6. 6-7. 3	Low to moderate.
CL or SC	A-6(3-12)	95-100	95-100	45-65	0. 63-2. 0	0. 14-0. 17	6. 6-7. 8	Moderate.
CL	A-6(4-8)	95-100	95-100	60-80	0. 63-2. 0	0. 15-0. 19	4. 5-6. 0	Moderate.
CL	A-6(6-8)	95-100	90-95	50-75	0. 63-2. 0	0. 14-0. 17	4. 5-5. 0	Moderate.
SM or SP-SM	A-2 or A-1-b	80-95	70-90	3-15	6. 3-20. 0+	0. 02-0. 04	4. 5-6. 0	None.
CL	A-6(4-8)	95-100	95-100	60-80	0. 63-2. 0	0. 15-0. 19	4. 5-6. 0	Moderate.
CL	A-6(6-8)	95-100	90-95	50-75	0. 63-2. 0	0. 14-0. 17	4. 5-5. 0	Moderate.
SM or SP-SM	A-2-4 or A-1-b	80-95	70-90	3-15	6. 3-20. 0+	0. 02-0. 04	4. 5-6. 0	None.
ML	A-4(6-8)	100	100	95-100	0. 63-2. 0	0. 19-0. 21	6. 6-7. 3	Moderate.
CL	A-4(8) or A-6(10-12)	100	100	95-100	0. 63-2. 0	0. 18-0. 20	5. 6-6. 0	Moderate.
OH or OL	A-7-5(9-14)	100	100	70-90	0. 63-2. 0	0. 19-0. 20	6. 6-7. 3	High to moderate.
CL	A-6(8-12)	95-100	95-98	60-80	0. 63-2. 0	0. 14-0. 18	7. 4-7. 8	Moderate.
CH	A-7-6(20)	100	100	90-100	<0. 06	0. 14-0. 18	7. 4-8. 4	High.
OL or CL	A-7-5(12-18)	100	100	80-90	0. 63-2. 0	0. 19-0. 21	6. 1-7. 3	High.
CL	A-6(8-12)	95-100	90-95	60-70	0. 06-0. 2	0. 15-0. 18	6. 6-7. 8	Moderate to high.
CL	A-6(8-12)	95-100	90-95	60-70	0. 06-0. 2	0. 15-0. 18	7. 4-7. 8	Moderate to high.
OL or CL	A-4(6) or A-6(10)	100	100	60-80	0. 63-2. 0	0. 17-0. 19	5. 6-6. 0	Moderate.
CL	A-6(6-10)	95-100	90-95	50-65	0. 20-0. 63	0. 14-0. 17	5. 1-5. 5	Moderate.
CL	A-6(6-10)	95-100	90-95	50-65	0. 20-0. 63	0. 14-0. 17	6. 1-7. 3	Moderate.
SM	A-2-4 or A-4	100	100	35-50	2. 0-6. 3	0. 10-0. 13	5. 1-5. 5	Low.
SC or SM	A-4	100	100	40-50	2. 0-6. 3	0. 10-0. 14	5. 1-6. 0	Low.
SM or SC	A-2-4 or A-3	100	100	5-20	6. 3-20. 0	0. 04-0. 08	5. 1-6. 0	Low or none.
CL or OL	A-6(6-10)	95-100	95-100	60-80	0. 63-2. 0	0. 18-0. 20	5. 6-6. 5	Moderate.
CL	A-6(8-12)	95-100	95-100	55-75	0. 63-2. 0	0. 14-0. 17	5. 6-6. 0	Moderate.
SM or SP	A-2 or A-1-b	85-95	70-90	5-15	6. 3-20. 0	0. 02-0. 04	5. 6-6. 0	None.
CL or OL	A-6(6-10)	95-100	95-100	60-80	0. 63-2. 0	0. 18-0. 20	5. 6-6. 5	Moderate.
CL	A-6(8-12)	95-100	95-100	55-75	0. 63-2. 0	0. 14-0. 17	5. 6-6. 0	Moderate.
SM or SP	A-2 or A-1-b	85-95	70-90	5-15	6. 3-20. 0	0. 02-0. 04	5. 6-6. 0	None.
SM	A-2-4 or A-4	95-100	90-95	25-40	6. 3-20. 0	0. 11-0. 13	5. 1-6. 0	Low.
SM or SP-SM	A-1-b	70-90	55-70	5-20	6. 3-20. 0	0. 02-0. 04	4. 5-5. 0	Very low or none.
SM or SW	A-1-b or A-2-4	70-95	60-95	5-35	>20. 0	0. 02-0. 04	4. 5-5. 0	None.
OL or CL	A-6(6-10)	100	100	65-80	0. 63-2. 0	0. 15-0. 19	5. 1-6. 0	Moderate.
CL	A-6(8-12)	95-100	95-100	50-70	0. 63-2. 0	0. 14-0. 17	4. 5-5. 0	Moderate.
CL	A-6(8-12) or A-7-6(10-14)	95-100	95-100	55-70	0. 06-0. 2	0. 15-0. 18	4. 5-7. 3	Moderate to high.
CL	A-6(8-12)	95-100	90-95	55-70	0. 06-0. 2	0. 15-0. 18	7. 4-7. 8	Moderate to high.

TABLE 3.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface (typical profile)	Classification
	Limestone bedrock	Seasonal high water table		USDA texture
	Feet	*Feet*	*Inches*	
Marsh: 354. Properties are too variable to be estimated.				
Marshan: 152, 153	>10	0–1½	0–18	Light clay loam
			18–38	Silty clay loam and heavy sandy loam.
			38–66	Gravelly loamy sand
Muck:				
21	>10	0–1	0–14	Muck
			14–60	Stratified silty clay loams to sand.
221	>10	0–1	0–37	Muck
			37–64	Stratified silt loams to sands
621	>10	0–1	0–47	Muck
			47–69	Stratified silty clay loams to sands.
Oran: 471A, 471B	>10	1½–2	0–17	Heavy loam
			17–52	Heavy loam
			52–66	Heavy loam
Ostrander: 394A, 394B, 394C, 394C2	>10	>5	0–23	Loam
			23–36	Heavy sandy loam
			36–74	Sandy loam, sandy clay, and loam.
Pinicon: 303B	>10	1½–2	0–17	Silt loam and loam
			17–44	Heavy loam and light clay loam
			44–68	Heavy loam
Port Byron: 620B	>10	>5	0–18	Silt loam
			18–32	Heavy silt loam
			32–72	Silt loam
Protivin: 798B	>10	1½–2	0–15	Heavy loam
			15–23	Heavy loam
			23–60	Clay loam
Racine: 482A, 482B, 482C, 482C2	>10	>5	0–14	Loam
			14–47	Loam and sandy clay loam
			47–72	Sandy clay loam
*Radford: 195B, 467. For properties of the Huntsville part of 195B, see Huntsville series.	>10	>5	0–33	Silt loam
			33–60	Loam and silt loam
Readlyn: 399A, 399B	>10	20–30 inches	0–19	Loam
			19–37	Heavy loam
			37–72	Heavy loam
Renova: 491B	>10	>5	0–14	Loam
			14–65	Loam to heavy sandy loam
			65–90	Loam

See footnotes at end of table.

significant in engineering—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
OL or OH	A-7-5(10-16)	100	95-100	70-85	0. 63-2. 0	0. 19-0. 21	6. 6-7. 3	High.
CL	A-6(9-13)	95-100	90-95	50-75	0. 63-2. 0	0. 15-0. 17	6. 6-7. 3	Moderate.
SM or SP	A-2 or A-1-b	80-95	70-95	5-15	6. 3-20. 0+	0. 02-0. 04	6. 6-7. 3	None.
Pt	Muck	(2)	(2)	(2)	(2)	0. 20-0. 25	6. 1-7. 3	Moderate.
CL, SC, or SM	A-6(6-10) to A-3	100	100	10-65	0. 63-2. 0	0. 06-0. 18	6. 6-7. 8	Low to moderate.
Pt	Muck	(2)	(2)	(2)	(2)	0. 20-0. 25	6. 6-7. 8	Moderate.
CL, SC, or SM	A-6(6-10) to A-2	100	100	10-65	0. 63-2. 0	0. 06-0. 18	7. 4-7. 8	Low to moderate.
Pt	Muck	(2)	(2)	(2)	(2)	0. 20-0. 25	6. 6-7. 8	Moderate.
CL, SC, or SM	A-6(6-10) to A-12	100	100	10-65	0. 63-2. 0	0. 06-0. 18	7. 4-7. 8	Low to moderate.
CL	A-6(6-10)	100	100	70-86	0. 63-2. 0	0. 15-0. 18	4. 5-7. 3	Moderate.
CL	A-6(6-10)	95-100	90-95	50-65	0. 2-0. 63	0. 14-0. 17	4. 5-5. 5	Moderate.
CL	A-6(6-10)	95-100	90-95	50-65	0. 2-0. 63	0. 14-0. 17	5. 6-6. 0	Moderate.
CL	A-6(6-10)	100	95-100	55-75	0. 63-2. 0	0. 16-0. 19	5. 6-6. 0	Moderate.
SC	A-2 or A-4 (1-5) or A-6(4-8)	90-95	90-95	30-50	0. 63-6. 3	0. 13-0. 17	5. 6-6. 0	Moderate to low.
CL or SC	A-4(1-5) or A-6(4-8)	90-95	90-95	30-60	0. 63-2. 0	0. 13-0. 17	6. 1-7. 4	Moderate to low.
ML or CL	A-4(4-8) or A-6(6-10)	100	100	75-85	0. 63-2. 0	0. 15-0. 19	4. 5-6. 0	Moderate.
CL	A-6(8-12)	95-100	90-95	55-65	0. 2-0. 63	0. 14-0. 17	4. 5-6. 0	Moderate.
CL	A-6(6-10)	95-100	90-95	55-65	0. 2-0. 63	0. 14-0. 17	6. 1-7. 8	Moderate.
ML or OL	A-4(6-8)	100	100	95-100	0. 63-2. 0	0. 19-0. 23	6. 6-7. 3	Moderate.
CL	A-6(8-12)	100	100	95-100	0. 63-2. 0	0. 19-0. 22	5. 1-5. 6	Moderate.
CL	A-6(8-12)	100	100	95-100	0. 63-2. 0	0. 19-0. 22	5. 6-6. 5	Moderate.
MH, OL or CL	A-7-5(11-16)	100	100	70-85	0. 63-2. 0	0. 18-0. 20	5. 1-5. 5	Moderate to high.
CL	A-6(6-12)	95-100	90-95	50-65	0. 63-2. 0	0. 14-0. 17	5. 6-6. 0	Moderate.
CL	A-6(8) to A-7-6(12)	95-100	90-95	60-70	0. 06-0. 2	0. 15-0. 18	6. 1-7. 8	Moderate to high.
CL or ML	A-4(4-8) or A-6(6-10)	100	100	55-80	0. 63-2. 0	0. 15-0. 18	5. 1-6. 0	Moderate.
CL or SC	A-6(4-8)	95-100	90-95	40-60	0. 63-2. 0	0. 13-0. 17	5. 1-6. 0	Moderate.
CL or SC	A-6(4-8)	95-100	90-95	40-60	0. 63-2. 0	0. 13-0. 17	6. 6-7. 3	Modertae.
OL or CL	A-4(2) to A-6(8)	100	100	95-100	0. 63-2. 0	0. 19-0. 20	6. 6-7. 3	Moderate.
OL or CL	A-6(8) to A-7-6(12)	100	100	70-90	0. 63-2. 0	0. 19-0. 20	6. 6-7. 3	Moderate.
CL or OL	A-7-5 or A-6(8-10)	100	100	70-80	0. 63-2. 0	0. 18-0. 20	5. 6-6. 0	Moderate.
CL	A-6(8-12)	95-100	90-95	50-65	0. 2-0. 63	0. 14-0. 17	6. 1-6. 5	Moderate.
CL	A-6(8-12)	95-100	90-95	50-65	0. 2-0. 63	0. 14-0. 17	6. 6-7. 8	Moderate.
ML-CL	A-4(4-8) or A-6(6-10)	100	95-100	55-80	0. 63-2. 0	0. 14-0. 17	4. 5-6. 5	Moderate.
CL or SC	A-6(4-8)	95-100	90-95	40-60	0. 63-6. 3	0. 13-0. 17	4. 5-5. 5	Moderate.
CL	A-6(6-10)	95-100	90-95	40-60	0. 63-2. 0	0. 13-0. 17	5. 1-6. 0	Moderate.

TABLE 3.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface (typical profile)	Classification
	Limestone bedrock	Seasonal high water table		USDA texture
	Feet	*Feet*	*Inches*	
Riceville: 784B	>10	1½–2	0–9	Loam
			9–20	Loam and light clay loam
			20–42	Clay loam
			42–60	Clay loam
Rockton: 213A, 213B, 213C	2½–3	>5	0–19	Loam
			19–35	Loam, clay loam, and sandy loam.
			35–40	Heavy clay loam and clay
			>40	Limestone bedrock.
214A, 214B, 214C, 214C2	2–2½	>5	0–15	Loam
			15–24	Clay loam
			24–28	Clay
			>28	Limestone bedrock.
Sattre: 778A	>10	>5	0–13	Loam
			13–39	Loam and sandy loam
			39–66	Loamy sand with some gravel
Saude: 177A, 177B, 284A, 284B	>10	>5	0–16	Loam
			16–28	Loam and heavy sandy loam
			28–60	Loamy sand and gravelly sand
Schley: 407B	>10	1½–2	0–22	Silt loam and loam
			22–46	Stratified loam and sandy loam
			46–63	Loam
Sogn: 412B, 412D, 412F	½–1½	>5	0–9	Heavy loam
			>9	Limestone bedrock.
Sparta: 41A, 41B, 41C	>10	>5	0–14	Loamy fine sand
			14–66	Fine and medium sand
*Spillville: 485, 585, 615. For properties of the Colo part of 585 and 615, see Colo series.	>10	3–4	0–52	Loam
			52–60	Stratified loam and loamy sand
Terril: 27A, 27B	Generally >10 ft.; 4 to 6 ft. in some places.	>5	0–29	Loam and silt loam
			29–47	Loam and sandy loam
			47–57	Gravelly loamy sand
Tripoli: 398	>10	1–2	0–15	Silty clay loam
			15–25	Clay loam
			25–67	Heavy loam
Turlin, acid variant: 96	>10	2½–3½	0–29	Gritty silt loam
			29–65	Gritty silt loam
			65–78	Loamy fine sand

See footnotes at end of table.

significant in engineering—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*		
OL or CL	A-6(6-10) or A-7-6(8-10)	100	100	70-85	0. 63-2. 0	0. 18-0. 20	4. 5-5. 6	Moderate to high.
CL	A-6(6-10)	85-100	85-100	55-65	0. 63-2. 0	0. 14-0. 17	4. 5-5. 0	Moderate.
CL	A-6(8-12)	95-100	90-95	60-70	0. 06-0. 20	0. 15-0. 18	4. 5-5. 5	Moderate to high.
CL	A-6(6-10)	95-100	90-95	60-70	0. 06-0. 20	0. 15-0. 18	7. 4-7. 8	Moderate to high.
CL	A-6(6-10)	100	100	55-75	0. 63-2. 0	0. 16-0. 19	6. 1-6. 5	Moderate.
CL or SC	A-6(4-10)	95-100	95-100	35-70	0. 63-2. 0	0. 13-0. 17	6. 1-6. 5	Moderate.
CH	A-7-6(13-18)	95-100	90-100	65-95	0. 2-0. 63	0. 15-0. 18	6. 6-7. 8	High.
CL	A-6(6-10)	100	100	55-75	0. 63-2. 0	0. 16-0. 19	6. 1-6. 5	Moderate.
CL	A-6(8-10)	95-100	95-100	50-75	0. 63-2. 0	0. 15-0. 18	6. 1-6. 5	Moderate.
CH	A-7-6(13-18)	95-100	90-95	65-90	<0. 06	0. 15-0. 18	6. 6-7. 3	High.
CL or ML	A-4(4-8)	100	90-95	55-75	0. 63-2. 0	0. 15-0. 18	6. 6-7. 3	Moderate.
CL or SC	A-4(1-5) or A-6(4-8)	100	90-95	40-60	0. 63-6. 3	0. 13-0. 17	5. 1-6. 0	Moderate.
SM or SP	A-2 or A-1-b	85-95	70-90	3-15	6. 3-20. 0	0. 04-0. 06	5. 1-5. 6	None.
CL	A-6(6-10)	95-100	90-95	55-80	0. 63-2. 0	0. 15-0. 19	5. 6-6. 0	Moderate.
CL or SC	A-4(2-6)	95-100	90-95	35-60	0. 63-6. 3	0. 13-0. 17	5. 1-6. 0	Moderate.
SM, SP, or SW	A-2 or A-1-b	80-95	70-95	3-15	6. 3-20. 0+	0. 04-0. 06	5. 1-6. 0	Very low to none.
CL or ML	A-6(8-10)	100	100	75-85	0. 63-2. 0	0. 15-0. 18	4. 5-6. 5	Moderate.
CL or SC	A-4(2-6) or A-6(4-8)	90-95	90-95	30-65	0. 63-2. 0	0. 13-0. 17	5. 1-5. 5	Moderate.
CL	A-6(4-8)	95-100	90-95	50-65	0. 20-0. 63	0. 14-0. 17	6. 1-7. 3	Moderate.
CL	A-6(4-8) or A-7-6(12-17)	75-100	70-90	55-75	0. 63-2. 0	0. 15-0. 18	6. 6-7. 8	Moderate.
SM	A-2-4	100	100	15-30	6. 3-20. 0+	0. 06-0. 08	5. 6-7. 3	Low or none.
SM	A-2-4 or A-3	100	100	5-20	6. 3-20. 0+	0. 02-0. 04	5. 6-6. 5	None.
OL or CL	A-4(2-6) or A-6(4-8)	100	100	70-85	0. 63-2. 0	0. 18-0. 20	5. 6-6. 6	Moderate.
CL or SM	A-4(2-6) or A-2-4	100	95-100	20-60	0. 63-2. 0	0. 10-0. 17	6. 1-6. 5	Moderate.
OL or CL	A-4(2-6) or A-6(4-8)	100	100	80-90	0. 63-2. 0	0. 20-0. 22	6. 6-7. 3	Moderate.
CL or SC	A-6(4-8) or A-4(2-6)	100	100	40-80	0. 63-2. 0	0. 14-0. 17	6. 1-7. 3	Moderate.
SM, SP, or SW	A-2 or A-1-b	85-100	70-95	3-15	6. 3-20. 0+	0. 04-0. 06	6. 6-7. 3	Very low or none.
OH or CL	A-7-5 (12-18)	100	100	80-90	0. 63-2. 0	0. 19-0. 21	6. 6-7. 3	High.
CL	A-6(8-12)	100	100	75-85	0. 63-2. 0	0. 16-0. 18	6. 6-7. 3	Moderate to high.
CL	A-6(6-10)	95-100	90-95	55-70	0. 2-0. 63	0. 14-0. 17	6. 6-7. 8	Moderate.
OL or CL	A-4(4) or A-6(8)	100	100	80-90	0. 63-2. 0	0. 19-0. 20	5. 1-6. 0	Moderate.
CL	A-4(6) or A-6(10)	100	100	70-90	0. 63-2. 0	0. 15-0. 18	5. 5-6. 6	Moderate.
SM	A-2	100	95-100	10-20	6. 3-20. 0	0. 04-0. 08	6. 6-7. 3	Very low or none.

TABLE 3.—*Estimated soil properties*

Soil series and map symbols	Depth to— Limestone bedrock	Depth to— Seasonal high water table	Depth from surface (typical profile)	Classification USDA texture
	Feet	*Feet*	*Inches*	
Wapsie: 777A, 777B, 777C	>10	>5	0–13	Loam
			13–29	Loam and heavy sandy loam
			29–60	Gravelly loamy sand and sand
Waukee: 178A, 178B	>10	>5	0–16	Loam
			16–35	Loam and sandy clay loam
			35–66	Gravelly loamy sand and gravelly sand.
Whalan: 207B, 207C	2–2½	>5	0–15	Loam
			15–19	Clay loam
			19–28	Clay
			>28	Limestone bedrock.
Winneshiek: 713A, 713B, 713C	2½–3	<5	0–13	Loam
			13–33	Loam, clay loam, and sandy loam.
			33–38	Silty clay
			>38	Limestone bedrock.
714A, 714B, 714C, 714C2, 714D	2–2½	>5	0–14	Loam
			14–23	Loam and clay loam
			23–27	Clay
			>27	Limestone bedrock.
Winneshiek, shaly subsoil variant: 148A	3½–10	>5	0–8	Loam
			8–22	Loam
			22–44	Silty clay

[1] Perched water table during extended wet periods.

TABLE 4.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. These soils appear in the

Soil series and map symbols	Suitability as a source of— Topsoil	Sand	Gravel	Limestone	Road fill	Soil features affecting— Highway location [1]	Farm ponds: Reservoir areas
Alluvial land: Mapped only in complexes with Colo soils in units 715 and 315. Properties too variable for interpretations to be made.							

See footnotes at end of table.

significant in engineering—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
CL or ML	A-4(4-8)	100	95-100	55-75	0. 63-2. 0	0. 15-0. 19	5. 1-6. 0	Moderate.
CL or SC	A-4(1-5) or A-6(2-8)	95-100	95-100	35-60	0. 63-6. 3	0. 13-0. 17	5. 6-6. 0	Moderate.
SM, SP, or SW	A-2 or A-1-b	85-100	70-95	3-15	6. 3-20. 0+	0. 02-0. 04	5. 1-5. 5	Very low to none.
CL	A-6(6-10)	100	95-100	65-80	0. 63-2. 0	0. 16-0. 19	5. 6-6. 5	Moderate.
CL	A-6(4-8)	95-100	95-100	55-75	0. 63-2. 0	0. 14-0. 17	5. 6-6. 0	Moderate.
SM or SP	A-2 or A-1-b	85-95	70-95	3-15	6. 3-20. 0	0. 02-0. 04	5. 6-6. 0	None.
ML or CL	A-4(4-8)	100	95-100	55-75	0. 63-2. 0	0. 14-0. 17	6. 1-7. 3	Moderate.
CL	A-6(8-12)	95-100	90-95	60-70	0. 63-2. 0	0. 15-0. 18	5. 6-6. 0	Moderate.
CH	A-7-6(13-18)	95-100	90-95	65-90	<0. 06	0. 15-0. 18	6. 1-7. 8	High.
CL or ML	A-4(4-8)	100	100	55-75	0. 63-2. 0	0. 15-0. 18	5. 6-6. 6	Moderate.
CL or SC	A-6(6-10) or A-4(2-6)	95-100	90-95	35-70	0. 63-6. 3	0. 13-0. 17	5. 1-5. 5	Moderate.
CH	A-7-6(13-18)	90-100	90-100	65-95	<0. 06	0. 14-0. 18	6. 6-7. 4	High.
CL or ML	A-4(4-8)	100	100	55-75	0. 63-2. 0	0. 15-0. 18	5. 6-6. 6	Moderate.
CL	A-6(6-10)	95-100	90-95	50-70	0. 63-2. 0	0. 15-0. 18	5. 1-5. 5	Moderate.
CH	A-7-6(13-18)	95-100	90-95	65-90	<0. 06	0. 15-0. 18	6. 1-6. 5	High.
OL or CL	A-4(4-8)	100	100	55-75	0. 63-2. 0	0. 15-0. 18	6. 1-6. 5	Moderate.
CL	A-6(2-8)	95-100	90-95	50-70	0. 63-6. 3	0. 13-0. 18	5. 1-6. 0	Moderate.
CH	A-7-6(20)	95-100	95-100	90-95	<0. 06	0. 16-0. 18	6. 6-7. 8	Moderate to high.

[2] Estimates not feasible.

properties of the soils

may have different properties and limitations. Therefore, it is necessary to follow carefully the instructions for referring to other series that first column]

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Embankments						

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Ankeny: 136A	Good in upper 2 feet; fair at a depth of 2 to 4 feet.	Fair in upper 20 to 40 inches; good below a depth of 40 inches: poorly graded fine and medium sand in most places.	Poor: some gravel below a depth of about 50 inches in places.	Not suitable	Fair to good except in upper 2 to 3 feet: moderate organic-matter content; low compressibility; good workability.	Nearly level; subject to occasional flooding; deep cuts encounter saturated sands in places; good bearing capacity; good to fair shear strength; surface layer has moderate content of organic matter.	Nearly level bottom lands; subject to flooding; porous substratum.
Backbone: 109B, 109C.	Fair to poor	Fair in upper 2 to 3 feet: poorly graded fine and medium sand.	Not suitable	Good: limestone suitable for crushing below a depth of 2 to 3 feet.	Good in material above limestone bedrock: low compressibility; limestone suitable if crushed.	Good bearing capacity above limestone bedrock; upper 2 to 5 feet is shattered limestone; bedrock at a depth of 2 to 3 feet.	Limestone bedrock below a depth of 2 to 3 feet; moderately rapid permeability; clayey residuum not continuous; too porous to hold water.
Bassett: 171A, 171B, 171C, 171C2.	Fair to good in upper 12 to 18 inches, poor below.	Not suitable	Not suitable	Not suitable	Good below a depth of about 2 feet: fair to good bearing capacity; easily compacted to high density.	Fair to good bearing capacity and fair shear strength below a depth of about 1½ feet: seepage in some cuts; susceptible to to frost action; perched water table in wet seasons.	Slow permeability if compacted; sandy pockets and lenses in places.
Burkhardt: 285C	Fair in upper 12 inches, very poor below.	Fair: well-graded sand and gravel below a depth of 12 to 18 inches.	Fair: well-graded sand and gravel below a depth of 12 to 18 inches.	Not suitable	Very good: well-graded sand and gravel; very low to negligible compressibility.	Good bearing capacity; erodible on steep slopes; good shear strength.	Shallow to sand and gravel; too porous to hold water.

See footnotes at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Porous when compacted; subject to piping.	Subject to occasional flooding; somewhat excessively drained.	Terraces not needed; ridges and channels difficult to maintain.	Not needed; nearly level bottom land.	Medium to low compressibility; subject to occasional flooding; good to fair bearing capacity and shear strength.	Slight, but possible danger of contamination of streams or water supply.	Severe: moderately rapid permeability; subject to occasional flooding.
Pervious even when compacted; limited amount of material available; low volume change with moisture.	Excessively drained.	Limestone bedrock below a depth of 2 to 3 feet in places.	Highly erodible; difficult to construct and vegetate.	Limestone bedrock at a depth of 2 to 3 feet; good bearing capacity and good to fair shear strength above bedrock.	Severe: poor filtering material; fractured bedrock below a depth of 2 to 3 feet; danger of contamination.	Severe: fractured limestone below a depth of 2 to 3 feet; danger of contamination.
Good stability; easily compacted to high density; moderate volume change with moisture; impervious when compacted.	Generally not needed; hillside seepage in places, tile may be beneficial in these spots.	Low fertility in subsoil; high density subsoil; wet spots may develop after terracing without tile; exposed glacial till has poor workability.	Seepy and wet; vegetation difficult to establish without tile.	Possible uneven consolidation; medium to low compressibility; fair to good bearing capacity; fair shear strength.	Moderate: moderately slow permeability; perched water table in extended wet periods.	Slight where slope is less than 2 percent; moderate where slope is 2 to 9 percent; sand pockets in places.
Pervious when compacted; fair resistance to piping; small volume change with moisture.	Excessively drained.	Shallow to sand and gravel; highly erodible; short, irregular slopes; ridges and channels difficult to maintain.	Highly erodible; very difficult to vegetate.	Good bearing capacity; good to excellent shear strength; little or no volume change with moisture.	Slight: very rapid permeability; severe danger of contamination.	Severe: very rapid permeability; substratum too porous to hold water; severe danger of contamination.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
*Clyde: 84, 391B. For Floyd part of 391B, see Floyd series.	Fair or good in upper 12 to 24 inches, fair below: seasonal high water table.	Not suitable	Not suitable	Not suitable	Very poor: high content of organic material; medium to high compressibility; seasonal water table at or near the surface.	Highly organic surface layer; seasonally high water table; poor bearing capacity and poor to fair shear strength above a depth of 3 to 4 feet; highly susceptible to frost action.	Some sandy lenses and pockets; highly organic surface layer; slow permeability below a depth of 3 feet if compacted.
Coggon: 302B	Fair in upper 12 to 18 inches; poor below.	Not suitable	Not suitable	Not suitable	Fair in upper 12 to 18 inches, good below: medium to low compressibility; easily compacted to high density.	Fair to good bearing capacity and fair shear strength below a depth of about 18 inches; seepage in some cuts; susceptible to frost action; perched water table in wet seasons.	Slow permeability if compacted; sand pockets and lenses of sand in places.
Colo: 133	Fair or good: seasonal high water table.	Fair below a depth of 4 feet.	Not suitable	Not suitable	Very poor: high content of organic material; seasonal high water table; medium to high compressibility.	Highly organic surface layer; seasonal high water table; subject to flooding; poor to fair shear strength; poor bearing capacity; highly susceptible to frost action.	Highly organic surface layer; moderately slow permeability if compacted; difficult to compact; subject to occasional flooding.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Poor stability in upper 2 feet and fair stability between depths of 2 and 3 feet; high organic-matter content; slow permeability below a depth of 40 inches if compacted; moderate to high volume change with moisture.	Seasonally high water table; stones and boulders interfere with tile installation in places; moderately permeable; wetness partly due to seepage.	Wetness hinders construction; poor stability may cause slippage if terraces are high.	Wet and seepy; needs tile to control seepage to establish vegetation; stones and boulders interfere with construction in places.	Seasonally high water table; poor bearing capacity and poor to fair shear strength above a depth of 3 feet; uneven consolidation; medium to high compressibility.	Severe: high water table.	Moderate: receives local runoff; highly organic surface layer; sandy lenses in subsoil.
Good stability; easily compacted to high density; moderate volume change with moisture.	Generally not needed; hillside seepage, in places, tile is beneficial in these places.	Low fertility in subsoil; high-density subsoil; wet spots may develop after terracing; subsoil has poor workability.	Seepy and wet; difficult to establish vegetation without tile.	Possible uneven consolidation; medium to low compressibility; fair to good bearing capacity and fair shear strength below a depth of about 1½ feet.	Moderate: moderately slow permeability; perched water table in extended wet periods.	Moderate: occasional sand pockets.
Highly organic surface layer; high volume change with moisture; difficult to compact to a high density.	Seasonal high water table; subject to flooding; moderately permeable; adequate tile outlets difficult to establish in places.	Not needed	Not needed	Subject to flooding; seasonal high water table; poor bearing capacity; high to medium compressibility; poor shear strength.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; highly organic surface layer.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Colo—Continued 315, 715	Variable, but good to fair in most places.	Variable, but good on sand bars adjacent to some stream channels.	Variable, but fair on some gravelly sand bars adjacent to some stream channels.	Not suitable	Good to poor: onsite investigation required.	Subject to flooding; some areas have high water table; many areas have a highly organic surface layer; variable soil materials.	Highly organic surface layer in most areas; too porous to hold water in places; subject to flooding; suitable sites unlikely.
Cresco: 783B, 783C.	Fair to good in upper 12 to 18 inches, poor below.	Not suitable	Not suitable	Not suitable	Good below a depth of about 2 feet: medium to low compressibility; fair to good bearing capacity; easily compacted to high density.	Highly organic surface layer; susceptible to frost action; seepage in some cuts; perched water table in wet periods.	Very slow permeability if compacted; pockets and and lenses of sand in places; highly or-organic surface layer.
*Dickinson: 175A, 175B, 575B, 576B. For Ostrander part of 575B and Racine part of 576B, see the Ostrander and Racine series, respectively.	Good in upper 12 to 18 inches, fair between depths of 18 and 36 inches, poor below.	Good below a depth of about 3 feet: poorly graded fine and medium sand.	Fair to poor: well-graded sand and gravel below a depth of 3 feet in a few places on benches.	Not suitable	Good: good workability; low compressibility; good bearing capacity if confined.	Highly erodible; seepage possible in some cuts on uplands; loose sand may hinder hauling; good bearing capacity and shear strength.	Substratum too porous to hold water; moderately rapid permeability.
Donnan: 782A, 782B.	Good in upper 6 to 12 inches, fair between depths of 12 and 24 inches, very poor below.	Not suitable	Not suitable	Not suitable	Fair in upper 12 to 24 inches, poor below: high volume change with moisture; poor workability; poor bearing capacity.	Poor bearing capacity and shear strength; perched water table in wet periods; highly susceptble to frost action; seepage in some cuts.	Very slow permeability; soil in reservoir areas not always uniform, contain pockets of sand in places.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Variable, but generally has highly organic surface layer; medium to high volume change with moisture in most areas and difficult to compact; some areas have low resistance to piping.	Subject to flooding; high water table in some areas; adequate tile outlets difficult to establish in places; surface drainage beneficial; water ponds in some depressional areas for long periods.	Not needed	Not needed	Subject to flooding; high water table in some areas; variable soil material.	Severe: subject to flooding; high water table in some areas.	Severe: subject to flooding; highly organic surface layer in most areas; rapid permeability in places.
Highly organic surface layer; good stability; easily compacted to high density; moderate volume change with moisture; impervious when compacted.	Seasonally wet; hillside seepage in places, tile may be beneficial in these spots; slow permeability.	Low fertility in subsoil; high density subsoil; wetness may increase with terrace installation; a combination of terracing and tiling is beneficial.	Seepy and wet; drainage needed to control seepage in order to establish suitable vegetation.	Good bearing capacity and fair shear strength below a depth of about 2 feet; low compressibility; uneven consolidation possible.	Severe: slow permeability; perched water table in wet periods.	Moderate where slope is less than 9 percent; pockets of sand in places; highly organic surface layer.
Pervious even if compacted; poor resistance to piping; low volume change with moisture.	Somewhat excessively drained.	Highly erodible; ridges and channels difficult to maintain; loose sand may hinder construction.	Highly erodible; difficult to vegetate.	Good bearing capacity and shear strength; low compressibility.	Slight: moderately rapid permeability in lower part of subsoil; moderate danger of contamination.	Severe: moderately rapid permeability in lower part of subsoil; material too porous to hold water.
Fair stability; poor workability; impervious if compacted; high volume change with moisture.	Perched water table in wet periods; very slow permeability.	Low fertility in subsoil; high-density subsoil; wetness may increase with terrace installation; cuts should be held to a minimum.	Seepy and wet; tile needed to establish vegetation.	Poor bearing capacity and shear strength; high compressibility; high volume change with moisture; uneven consolidation possible.	Severe: subsoil is very slowly permeable.	Slight where slope is less than 2 percent, moderate where slope is 2 to 5 percent; pockets of sand in places.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Downs: 162B, 162C, 162C2, 162D2, 162E2.	Good in upper 6 to 12 inches, fair below.	Not suitable	Not suitable	Not suitable	Fair to poor: medium to high compressibility; loss of bearing capacity when wet.	Fair to poor bearing capacity; fair shear strength; susceptible to frost action; highly erodible; easy to vegetate.	Moderately permeable; uniform soil material; difficult to compact to high enough density to prevent seepage.
Fayette: 163C, 163D, 163E, 163F.	Good in upper 6 to 12 inches, fair below.	Not suitable	Not suitable	Not suitable	Fair to poor: medium to high compressibility; loss of bearing capacity when wet.	Rolling relief; fair to poor bearing capacity; fair shear strength; susceptible to frost action; highly erodible; easy to vegetate.	Moderately permeable; uniform soil material; difficult to compact to high enough density to prevent seepage.
Floyd: 198B	Good in upper 18 to 24 inches, fair between depths of 2 and 3 feet.	Not suitable	Not suitable	Not suitable	Poor: high content of organic matter in upper 2 feet; seasonal water table; medium compressibility.	Fair bearing capacity and shear strength below a depth of about 2 feet; seasonal high water table; highly organic surface layer; highly susceptible to frost action; seepage in cuts.	Sand lenses or pockets in many places; variable soil materials; slow permeability below a depth of 3 feet if compacted.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Fair stability; semipervious if compacted; difficult to compact to high density; moderate volume change with moisture.	Well drained	All features favorable.	All features favorable.	Fair to poor bearing capacity and shear strength; medium compressibility.	Slight where slope is less than 5 percent, moderate where slope is 5 to 9 percent, and severe where slope is more than 9 percent; moderate permeability.	Moderate where slope is 2 to 9 percent; severe where slope is more than 9 percent.
Fair stability; semipervious if compacted; difficult to compact to high density; moderate volume change with moisture.	Well drained	All features favorable.	All features favorable.	Fair to poor bearing capacity and shear strength; medium compressibility.	Moderate where slope is 5 to 9 percent, severe where slope is more than 9 percent.	Moderate where slope is 5 to 9 percent, severe where slope is more than 9 percent.
Fair stability; can be compacted to high density; fair resistance to piping; moderate volume change with moisture; high in content of organic matter.	Seasonal high water table; moderate permeability; wetness due in part to laterally moving water; drainage designed to intercept seepage is most likely to be successful.	Not all areas need terraces or diversions, but if installed, a combination of terracing and tiling may be the most effective.	Seepy and wet; needs drainage to establish vegetation.	Seasonal high water table at a depth of 1½ to 2 feet; fair bearing capacity and shear strength below a depth of 2 to 3 feet; uneven consolidation; medium compressibility.	Severe: seasonal high water table.	Moderate: highly organic surface layer; variable soil material; some pockets and strata of sand.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Hayfield:							
725	Good in upper 12 inches, fair between depths of 12 and 24 inches, very poor below a depth of 24 inches.	Good below a depth of about 2 feet: well-graded fine to coarse sand or well-graded sand and gravel.	Fair below a depth of about 2 feet: well-graded fine to coarse sand; contains too many fines in places.	Not suitable	Fair in upper 2 feet, good below a depth of about 2 feet: very low compressibility; good workability; seasonal water table at a depth of 2 to 3 feet.	Seasonal water table at a depth of 30 to 36 inches; susceptible to frost action; fair bearing capacity and shear strength at a depth of 8 to 27 inches; good bearing capacity and good to excellent shear strength below a depth of 27 inches.	Nearly level stream benches; sand and gravel at a depth of about 2 feet.
726	Good in upper 12 inches, fair between depths of 12 and 36 inches, very poor below.	Good below a depth of about 3 feet: well-graded fine to coarse sand or well-graded sand and gravel.	Poor below a depth of about 3 feet: well-graded fine to coarse sand; contains too many fines in places.	Not suitable	Fair in upper 3 feet; good below a depth of about 3 feet: very low compressibility; good workability; seasonal water table at a depth of 2 to 3 feet.	Seasonal water table at a depth of 2 to 3 feet; susceptible to frost action; fair bearing capacity and shear strength at a depth of 2 to 3 feet; good bearing capacity and good to excellent shear strength below a depth of 3 feet.	Nearly level soils on stream benches; sand and gravel at a depth of about 3 feet.
Huntsville. Mapped only in a complex with Radford soils in unit 195B.	Good to a depth of 12 to 36 inches, fair below.	Not suitable	Not suitable	Not suitable	Poor: medium to high compressibility; high content of organic matter; difficult to compact to high density.	Subject to local flooding of high-velocity and short duration; high organic-matter content; poor bearing capacity.	Moderately permeable; uniform material; difficult to compact to high enough density to prevent seepage.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Fair to good stability; low volume change with moisture; poor resistance to piping.	Seasonal high water table; benefits from tile in wet periods; tile placement is difficult in places because of unstable sand.	Not needed	Generally not needed.	Seasonal water table at a depth of 2 to 3 feet; good bearing capacity and shear strength below a depth of about 2 feet; very low compressibility.	Moderate: seasonal water table at a depth of 2 to 3 feet; severe danger of contamination.	Severe: substratum too porous to hold water; severe danger of contamination.
Fair to good stability; low volume change with moisture; poor resistance to piping.	Seasonal high water table; will benefit from tile drainage in wet periods; tile placement is difficult in places because of unstable sand.	Not needed	Generally not needed.	Seasonal water table at a depth of 2 to 3 feet; good bearing capacity and shear strength below a depth of about 3 feet; very low compressibility.	Moderate: seasonal water table at a depth of 2 to 3 feet; moderate danger of contamination.	Severe: substratum too porous to hold water; moderate danger of contamination.
Fair stability; semipervious if compacted; moderate volume change with moisture.	Well drained	Not needed; soil features favorable for diversions.	All features favorable.	Subject to flooding of high velocity; poor bearing capacity; fair shear strength; medium to high compressibility.	Moderate: local flooding may damage filter fields.	Moderate: subject to local flooding; highly organic surface layer.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds — Reservoir areas
Jacwin: 444	Good in upper 12 to 18 inches, poor below.	Not suitable	Not suitable	Not suitable	Very poor: shale at a depth of 2 to 2½ feet; high content of organic matter in surface layer; very high compressibility; shale subject to high volume change with moisture.	Highly organic surface layer; poor bearing capacity and shear strength; seasonal water table at a depth of 2 to 2½ feet.	Shallow to very slowly permeable shale; contains thin strata of limestone in places.
Jameston: 797	Fair in upper 2 feet, poor below a depth of 2 feet: high water table.	Not suitable	Not suitable	Not suitable	Very poor in upper 2 feet, fair to good below a depth of 2 feet: medium to low compressibility; fair to good bearing capacity; easily compacted to high density.	Highly organic surface layer; seasonally perched water table; seepy in some cuts; susceptible to frost action where pockets of water-bearing sand occur.	Slow to very slow permeability if compacted; highly organic surface layer; sand lenses and pockets in places.
Kenyon: 83B, 83C, 83C2.	Good in upper 12 inches, fair between depths of 12 and 24 inches, poor below.	Not suitable	Not suitable	Not suitable	Good below a depth of 1½ to 2 feet: low compressibility; easily compacted to high density.	Highly organic surface layer; fair to good bearing capacity and fair shear strength below a depth of 1½ to 2 feet; seepage in some cuts; highly susceptible to frost action where pockets of water-bearing sand occur.	Slow permeability when compacted; sand pockets and lenses in places.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Poor stability; high volume change with moisture; impervious if compacted; high in content of organic matter.	Seasonal water table at a depth of 2 to 3 feet; very slowly permeable; tile may not drain all areas; proper placement and spacing are important.	Not needed	Seepy and wet; tile needed to establish vegetation.	Poor bearing capacity and shear strength; high compressibility; highly susceptible to frost action; seasonal water table at a depth of 2 to 3 feet; high volume change with moisture.	Severe: very slow permeability; seasonal water table at a depth of 2 to 3 feet.	Slight: highly organic surface layer; very slowly permeable; contains thin strata of limestone in places.
Highly organic surface layer; fair stability; easily compacted to high density; impervious if compacted; moderate volume change with moisture.	High water table; slow permeability; requires closer spacing and more shallow placement of tile than is recommended for other soils in the county.	Not needed	Wet and seepy; needs drainage to establish vegetation.	Seasonal high water table at a depth of 1½ to 2 feet; good to fair bearing capacity and fair shear strength below a depth of about 2 feet; medium to low compressibility; uneven consolidation possible.	Severe: high water table; slow permeability.	Slight: receives local runoff; highly organic surface layer; sand pockets in places.
Good stability; easily compacted to high density; moderate volume change with moisture.	Generally not needed; hillside seepage in some places, tile may be beneficial in these spots.	Low fertility; high density of subsoil; wet spots may develop after terracing; a combination of terracing and tile drains needed in places.	Seepy and wet; requires tile to establish suitable vegetation.	Fair to good bearing capacity and fair shear strength below a depth of 1½ to 2 feet; medium to low compressibility; uneven consolidation possible.	Moderate where slope is less than 9 percent, severe where more than 9 percent: moderately slowly permeable.	Moderate where slope is 2 to 9 percent: sand strata in places; highly organic surface layer.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Lamont: 110A, 110B, 110C.	Fair in upper 2 feet, poor below.	Good below a depth of 2 feet: poorly graded fine and medium sand.	Fair: well-graded sand and gravel below a depth of 3 feet in a few places on benches; contains too many fines in places.	Not suitable	Good: good workability; low compressibility; low volume change with moisture.	Highly erodible; loose sand may hinder hauling; good bearing capacity and shear strength; some cuts may contain saturated sands in places.	Substratum too porous to hold water; moderately rapid permeability.
Lawler:							
225	Good to a depth of 1½ feet, fair between depths of 1½ and 2½ feet, poor below a depth of 2½ feet.	Good below a depth of about 2 feet: well-graded fine to coarse sand that contains some gravel.	Fair below a depth of about 2 feet: well-graded coarse sand and some gravel; contains too many fines in places.	Not suitable	Good below a depth of about 2 feet: low compressibility; good workability; seasonal water table at a depth of 2 to 3 feet; high content of organic material.	Seasonal water table at a depth of 2 to 3 feet; high organic-matter content in surface layer; susceptible to frost action; good bearing capacity and shear strength below a depth of 2 feet.	Nearly level stream bench; sand and gravel at a depth of about 2 feet.
226	Good to a depth of 1½ feet, fair between depths of 1½ and 2½ feet, poor below a depth of 3 feet.	Good below a depth of about 3 feet: well-graded fine to coarse sand that contains some gravel.	Fair below a depth of about 3 feet: well-graded coarse sand that contains some gravel; contains too many fines in places.	Not suitable	Good below a depth of about 3 feet: low compressibility; good workability; seasonal water table at a depth of 2 to 3 feet; high content of organic material.	Seasonal water table at a depth of 2 to 3 feet; high organic-matter content in surface layer; susceptible to frost action; good bearing capacity and shear strength at a depth of about 3 feet.	Nearly level stream bench; sand and gravel at a depth of about 3 feet.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Fair stability; pervious even if compacted; poor resistance to piping; low volume change with moisture.	Somewhat excessively drained.	Highly erodible; ridges and channels difficult to maintain; loose sand may hinder construction.	Highly erodible; difficult to vegetate.	Good bearing capacity and shear strength; low compressibility; low volume change with moisture.	Slight: moderately rapid permeability in lower part of subsoil; moderate danger of contamination.	Severe: moderately rapid permeability in lower part of subsoil; material too porous to hold water.
Fair to good stability; low volume change with moisture; poor resistance to piping.	Seasonal high water table at a depth of 2 to 3 feet; benefits from tile in wet periods; tile placement is difficult in places because of water-bearing sand.	Not needed	Nearly level relief; all features favorable.	Seasonal water table at a depth of 2 to 3 feet; good bearing capacity and shear strength; low volume change with moisture.	Moderate: seasonal water table at a depth of 30 to 36 inches; severe danger of contamination.	Severe: substratum too porous to hold water; severe danger of contamination; highly organic surface layer.
Fair to good stability; low volume change with moisture; poor resistance to piping.	Seasonal water table at a depth of 2 to 3 feet; will benefit from tile in wet periods; tile placement is difficult in places because of water-bearing sand.	Not needed; nearly level relief.	Nearly level relief; all soil features favorable.	Seasonal water table at a depth of 2 to 3 feet; good bearing capacity and shear strength below a depth of 2 or 3 feet; low volume change with moisture.	Moderate: seasonal water table at a depth of 2 to 3 feet; moderate danger of contamination.	Severe: substratum too porous to hold water; moderate danger of contamination; highly organic surface layer.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Lilah: 776A, 776C, 776D.	Fair in upper 12 inches, very poor below.	Good: well-graded sand and some gravel below a depth of 12 to 18 inches.	Fair: well-graded sand and gravel below a depth of 12 to 18 inches; contains too many fines in places.	Not suitable	Very good: well-graded sand and gravel; very low to negligible compressibility; little or no volume change with moisture.	Good bearing capacity and shear strength; erodible in sloping areas.	Shallow; rapidly permeable sand and gravel, too porous to hold water.
Lourdes: 781B, 781C.	Good in upper 6 to 12 inches, poor below.	Not suitable	Not suitable	Not suitable	Fair in upper 1½ feet, good below a depth of 1½ feet: medium to low compressibility; easily compacted to high density.	Good bearing capacity and fair shear strength below a depth of about 1½ feet; seepage in some road cuts; perched water table in wet seasons; susceptible to frost action.	Slow to very slow permeability when compacted; sand pockets and lenses in places.
Marsh: 354	Poor: water table is at or near the surface.	Not suitable	Not suitable	Not suitable	Very poor: water table at or near surface; high content of organic matter.	Water table at or near the surface; subject to flooding; material quite variable.	Level or depressional topography; some areas suitable for dug-out ponds.
Marshan: 152, 153	Good to a depth of 1½ feet, fair between depths of 1½ and 3 feet: seasonal high water table.	Good below a depth of about 3 feet: well-graded fine and medium sand that contains a small amount of coarse gravel.	Fair below a depth of 3 feet: small amount of gravel; contains too many fines in places.	Not suitable	Upper part is very poor: high content of organic material; medium to high compressibility; seasonal water table at or near the surface. Good below a depth of about 3 feet: low compressibility; good workability.	Highly organic surface layer; seasonal high water table; subject to occasional flooding, especially in depressional areas.	Substratum too porous to hold water, but some areas can be filled by high water table; water table fluctuates to some extent with the season.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Pervious although compacted; poor resistance to piping; slight volume change with moisture.	Excessively drained.	Shallow to sand and gravel; highly erodible; short to very short slopes; ridges and channels difficult to maintain.	Highly erodible; vegetation very difficult to establish.	Good bearing capacity and shear strength; little or no volume change with moisture.	Severe: rapid permeability; severe danger of contamination.	Severe: rapid permeability; substratum too porous to hold water; severe danger of contamination.
Good stability; easily compacted to high density; moderate volume change with moisture: impervious if compacted.	Seasonally wet; hillside seepage in places, tile may be beneficial in these spots; slow permeability.	Low fertility in subsoil; high-density subsoil; wetness may increase with terrace installation; combination of terracing and tile needed in places.	Seepy and wet; tile needed to establish vegetation.	Good bearing capacity and fair shear strength below a depth of about 1½ feet; medium to low compressibility; uneven consolidation possible.	Severe: slow permeability; perched water table in wet periods.	Moderate where slope is 2 to 9 percent; slowly permeable.
Contains organic material in places; very poor stability.	Generally not practical; water table at or near the surface; satisfactory outlets difficult to obtain; subject to flooding.	Not needed	Not needed	Water table at or near the surface; very poor bearing capacity; poor shear strength; frequent flooding.	Very severe: water table at or near the surface; subject to frequent flooding; danger of contamination.	Vere severe: subject to frequent flooding; danger of contamination.
Fair to poor stability; poor resistance to piping.	Seasonally high water table; moderately permeable; tile placement difficult in a few places because of water-bearing loose sand; suitable outlets difficult to obtain in places.	Not needed	Nearly level relief; seasonal high water table; wet and seepy.	Seasonal high water table at or near the surface; subject to occasional flooding; good bearing capacity and shear strength below a depth of about 3 feet.	Severe: high water table; slight danger of contamination.	Severe: highly organic surface layer; subject to occasional flooding; substratum too porous to hold water; moderate danger of contamination.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds — Reservoir areas
Muck:							
21	Good to a depth of 1½ feet if mixed with mineral soil: seasonal water table at or near the surface.	Not suitable	Not suitable	Not suitable	Unsuitable for construction to a depth of 1½ feet, fair to good below a depth of 1½ feet: seasonal high water table at or near the surface.	Extremely poor bearing capacity and shear strength; fair bearing capacity and shear strength below a depth of about 1½ feet; very high water table.	Some sandy lenses and pockets; very highly organic surface layer; variable permeability below a depth of about 1½ feet; suitable sites unlikely.
221	Good to a depth of 3 feet if mixed with mineral soil: seasonal water table at or near the surface.	Not suitable	Not suitable	Not suitable	Unsuitable for construction: organic material to a depth of 3 feet.	Highly compressible organic material to a depth of 3 feet; water table at or near the surface; poor bearing capacity and shear strength.	Organic material to a depth of 3 feet, variable material below; suitable sites unlikely.
621	Good to a depth of 4 feet if mixed with mineral soil: seasonal water table at or near the surface.	Not suitable	Not suitable	Not suitable	Unsuitable for construction: organic material to a depth of 4 feet.	Highly compressible; organic material to a depth of 4 feet; water table at or near the surface; poor bearing capacity and shear strength.	Organic material to a depth of 4 feet, variable materials below; suitable sites unlikely.
Oran: 471A, 471B	Fair to good in upper 1½ feet, poor below.	Not suitable	Not suitable	Not suitable	Good below a depth of about 1½ feet: medium to low compressibility; seasonal water table at a depth of 2 to 3 feet; easily compacted to high density.	Fair to good bearing capacity and fair shear strength below a depth of 1½ feet; low relief; seepage in some cuts; susceptible to frost action where pockets of water-bearing sand occur.	Slow permeability if compacted; sand pockets and lenses in places.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Fair stability below a depth of about 1½ feet; easily compacted to high density; low resistance to piping; low to moderate volume change with moisture.	Very high seasonal water table; water-bearing loose sand may hinder installation.	Generally not needed.	Generally not needed.	Very high seasonal water table; organic material to a depth of 1 to 2 feet, variable materials below; uneven consolidation; medium compressibility.	Severe: very high water table.	Moderate: very highly organic soil to a depth of 12 to 24 inches, variable material below.
High content of organic matter to a depth of 3 feet.	Very high seasonal water table; organic material to a depth of 3 feet; alinement of tile difficult to maintain.	Generally not needed.	Generally not needed.	Very high seasonal water table; organic material to a depth of 3 feet.	Severe: very high water table.	Severe: organic material to a depth of 3 feet.
Organic material to a depth of 4 feet; very poor stability.	Very high seasonal water table; organic material to a depth of 4 feet; alinement of tile difficult to maintain.	Not needed	Generally not needed; very wet and seepy; organic material.	Very high water table; organic material to a depth of 4 feet.	Severe: very high water table.	Severe: organic material to a depth of 4 feet.
Good stability; easily compacted to high density; impervious if compacted; moderate volume change with moisture.	Seasonal high water table; moderately slow permeability.	Low fertility of subsoil: high-density subsoil; exposed glacial till has poor workability; wetness increases with terrace installation; a combination of terracing and tiling may be the most successful practice.	Seepy and wet; needs drainage to establish vegetation.	Seasonal high water table at a depth of 2 to 3 feet; uneven consolidation possible; medium to low compressibility; fair to good bearing capacity and fair shear strength below a depth of about 1½ feet.	Severe: seasonal high water table; moderately slow permeability.	Slight where slope is 0 to 2 percent, moderate where slope is 2 to 5 percent: sand pockets in places.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Ostrander: 394A, 394B, 394C, 394C2.	Good to a depth of 12 inches, fair between depths of 12 and 24 inches, poor below.	Not suitable	Not suitable	Not suitable	Fair to a depth of 2 feet, good below; medium to low compressibility below; easily compacted to high density.	Fair to good bearing capacity and shear strength; highly organic surface layer; highly susceptible to frost action where pockets of water bearing sand occur.	Sand pockets and lenses in many places; slow permeability if compacted.
Pinicon: 303B	Fair in upper 12 to 18 inches, poor below a depth of 12 to 18 inches.	Not suitable	Not suitable	Not suitable	Fair to a depth of 1½ feet, good below a depth of 1½ feet: medium to low compressibility; seasonal perched water table.	Fair to good bearing capacity and fair shear strength below a depth of about 1½ feet; seepage in some cuts; highly susceptible to frost action where pockets of water-bearing sand occur.	Slow permeability if compacted; sand pockets and lenses in places.
Port Byron: 620B	Good to a depth of 1½ feet, fair below.	Not suitable	Not suitable	Not suitable	Poor in upper 1½ feet, fair to poor below: medium to high compressibility; loss of bearing capacity where soil material is wet.	Fair to poor bearing capacity; fair shear strength; susceptible to frost action; highly erodible; easy to vegetate.	Moderately permeable; uniform material; difficult to compact to high enough density to prevent seepage.
Protivin: 798B	Good to a depth of 12 inches, fair between depths of 12 to 24 inches, poor below.	Not suitable	Not suitable	Not suitable	Poor to a depth of 1½ feet, good below: medium to low compressibility; seasonal water table at a depth of 1½ to 2½ feet.	Good bearing capacity and fair shear strength below a depth of about 2 feet; highly organic surface layer; highly susceptible to frost action; seepage in some cuts.	Slow to very slow permeability if compacted; sand pockets and lenses in places.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Good stability; easily compacted to high density; impervious if carefully compacted; moderate to low volume change with moisture.	Well drained	Low fertility of subsoil.	Some waterways are wet and seepy; needs drainage to establish vegetation.	Fair to good bearing capacity and shear strength below a depth of about 2 feet; medium to low compressibility; uneven consolidation possible.	Slight where slope is 0 to 2 percent, moderate where slope is 2 to 9 percent: moderate permeability.	Slight where slope is 0 to 2 percent, moderate where slope is 2 to 9 percent: sand pockets in places; highly organic surface layer.
Good stability; easily compacted to high density; impervious if compacted; moderate volume change with moisture.	Seasonal high water table; moderately slow permeability.	Low fertility of subsoil; high density subsoil; exposed glacial till has poor workability; wetness may increase with terrace installation; a combination of terracing and tiling may be most successful.	Seepy and wet; needs drainage to establish vegetation.	Seasonal high water table; uneven consolidation possible; medium to low compressibility; fair to good bearing capacity and shear strength below a depth of about 1½ feet.	Severe: seasonal high water table; moderately slow permeability.	Slight: easily compacted to high density; moderately slow permeability; sand pockets in places.
Fair stability; semipervious if compacted; difficult to compact to high density; moderate volume change with moisture; susceptible to piping.	Well drained	All features favorable.	Easy to vegetate.	Fair to poor bearing capacity and fair shear strength; medium compressibility.	Slight	Moderate: highly organic surface layer.
Highly organic surface layer; good stability; easily compacted to high density; impervious if compacted; moderate volume change with moisture.	Seasonal high water table; slowly permeable; tile may not drain all areas; careful spacing and placement of tile are important.	Low fertility of subsoil; high density subsoil; exposed glacial till has very poor workability; wetness increases with terrace installation; a combination of terracing and tiling may be most successful.	Wet and seepy; needs drainage to establish vegetation.	Seasonal high water table at a depth of 1½ to 2½ feet; good bearing capacity and fair shear strength below a depth of about 2 feet; medium to low compressibility; uneven consolidation possible.	Severe: slow permeability; seasonal high water table.	Slight where slope is less than 2 percent, moderate where slope is 2 to 4 percent; sand pockets in places; highly organic surface layer.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Racine: 482A, 482B, 482C, 482C2.	Fair to a depth of 1 foot, poor below.	Not suitable	Not suitable	Not suitable	Fair in upper 1½ feet, good below: medium to low compressibility; easily compacted to high density.	Fair to good bearing capacity and shear strength below a depth of about 1½ feet; highly susceptible to frost action where water bearing sand pockets occur.	Sand pockets and lenses in many places; slow permeability when compacted.
*Radford: 195B, 467. For Huntsville part of unit 195B, see Huntsville series.	Good to a depth of 3 to 4 feet.	Not suitable	Not suitable	Not suitable	Poor: high compressibility; high content of organic matter to a depth of 3 feet or more; difficult to compact to high density.	Low on rolling landscape and along streams; poor bearing capacity; fair shear strength; highly susceptible to frost action; subject to flooding.	Moderately permeable; uniform material; difficult to compact to sufficient density to prevent seepage.
Readlyn: 399A, 399B.	Good to a depth of 1½ feet, poor below.	Not suitable	Not suitable	Not suitable	Fair to a depth of 1½ feet, good below a depth of about 1½ feet: medium to low compressibility; seasonal water table at a depth of 1½ to 2½ feet; easily compacted to high density.	Highly organic surface layer; fair to good bearing capacity and fair shear strength below a depth of about 1½ feet; seepage in some cuts; highly susceptible to frost action where pockets of water-bearing sand occur.	Slow permeability if compacted; sand pockets and lenses in places.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued: Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Limitations of soil for—: Septic tank absorption fields	Sewage lagoons
Good stability; easily compacted to high density; impervious if carefully compacted; moderate to low volume change with moisture.	Well drained	Low fertility; high density subsoil.	Some waterways are wet and seepy; needs drainage to establish vegetation.	Fair to good bearing capacity and shear strength below a depth of about 1½ feet; medium to low compressibility; uneven consolidation.	Slight to moderate where slope is 0 to 2 percent, moderate where slope is 2 to 9 percent: moderate permeability.	Slight where slope is 0 to 2 percent, moderate where slope is 2 to 9 percent: sand pockets in places.
Fair stability; semipervious if compacted; difficult to compact to high density; moderate volume change with moisture.	Protection from local flooding may be beneficial; most areas do not need tiling.	Not needed; nearly level relief; soil features favorable.	All features favorable.	Poor bearing capacity; fair shear strength; subject to flooding of high velocity and short duration; high compressibility.	Severe: subject to flooding.	Severe: subject to flooding; high content of organic matter.
Good stability; easily compacted to high density; impervious if compacted; moderate volume change with moisture.	Seasonal high water table; moderately slow permeability.	Low fertility in subsoil; high density subsoil; exposed glacial till has poor workability; wetness increases with terrace installation; a combination of terracing and tiling may be most successful.	Seepy and wet; needs drainage to establish vegetation.	Seasonal high water table at a depth of 1½ to 2½ feet; uneven consolidation possible; medium to low compressibility; fair to good bearing capacity; fair shear strength.	Severe: seasonal high water table.	Slight where slope is 0 to 2 percent, moderate where slope is 2 to 5 percent: highly organic surface layer.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Renova: 491B	Fair to a depth of 1 foot, poor below.	Not suitable	Not suitable	Not suitable	Fair to a depth of 1 foot, good below: medium to low compressibility; easily compacted to high density.	Fair to good bearing capacity and shear strength below a depth of about 1 foot; highly susceptible to frost action where pockets of water-bearing sand occur.	Sand pockets and lenses in places; slow permeability when compacted.
Riceville: 784B	Fair to a depth of 1½ feet, poor below.	Not suitable	Not suitable	Not suitable	Fair to a depth of 1½ feet, good below: medium to low compressibility; easily compacted to high density.	Good bearing capacity and fair shear strength below a depth of about 1½ feet; highly susceptible to frost action where pockets of water-bearing sand occur.	Slow to very slow permeability if compacted; sand pockets and lenses in places.
Rockton: 213A, 213B, 213C.	Good to a depth of 2 feet; limestone at a depth of about 3 feet.	Not suitable	Not suitable	Limestone at a depth of 2½ to 3 feet suitable for crushing.	Fair to good in upper 2 to 3 feet; limestone below a depth of 3 feet good if crushed.	Highly organic surface layer; bedrock at a depth of 2½ to 3 feet; upper 2 to 5 feet of limestone is shattered; fair to good bearing capacity and shear strength above limestone.	Fractured limestone at a depth of 2½ to 3 feet.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Good stability; easily compacted to high density; impervious if carefully compacted; moderate to low volume change with moisture.	Well drained	Low fertility in subsoil.	Some waterways are wet and seepy and need tile drainage to establish vegetation.	Fair to good bearing capacity and shear strength below a depth of about 1 foot; medium to low compressibility; uneven consolidation.	Moderate where slope is 2 to 5 percent: moderate permeability.	Moderate: sand pockets in some places.
Good stability; easily compacted to high density; impervious if compacted; moderate volume change with moisture.	Seasonal high water table; slowly permeable; tile may not drain all areas; careful spacing and placement of tile are important.	Low fertility in subsoil; high-density subsoil; exposed glacial till has very poor workability; wetness increases with terrace installation; a combination of terracing and tiling may be most sucessful.	Wet and seepy; needs tile drainage to establish vegetation.	Seasonal high water table at a depth of 1½ to 2½ feet; good bearing capacity and fair shear strength below a depth of about 1½ feet; medium to low compressibility.	Severe: slow permeability; seasonal high water table.	Slight where slope is less than 2 percent, moderate where slope is 2 to 4 percent; sand pockets in places.
Good stability; limited material available; good workability; easily compacted to high density; moderate volume change with moisture.	Well drained	Limestone below a depth of 2½ to 3 feet may interfere with construction.	Limestone below a depth of 2½ to 3 feet may interfere with construction; easy to vegetate.	Fair to good bearing capacity and fair shear strength above limestone; limestone bedrock at a depth of about 3 feet.	Moderate: fractured limestone below a depth of 2½ to 3 feet; danger of contamination of water supply.	Severe: fractured limestone below a depth of 2½ to 3 feet.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Rockton—Continued 214A, 214B, 214C, 214C2.	Good to a depth of 1½ feet, poor below.	Not suitable	Not suitable	Limestone below a depth of 2 feet suitable for crushing.	Fair in upper 2 feet; limestone below a depth of 2 feet good if crushed.	Highly organic surface layer; bedrock at a depth of 20 to 30 inches; upper 2 to 5 feet of bedrock is shattered and free; fair bearing capacity and shear strength above limestone.	Shallow to fractured bedrock; too porous to hold water.
Sattre: 778A	Good in upper 6 inches, fair to a depth of about 3 feet.	Good below a depth of about 3 feet: well-graded fine to medium sand, some coarse sand, and a small amount of gravel.	Fair below a depth of about 3 feet; small amount of gravel; contains too many fines in places.	Not suitable	Fair to a depth of about 3 feet, good below; very low compressibility; good workability; little or no volume change with moisture.	Fair bearing capacity and shear strength in upper 3 feet; good bearing capacity and good shear strength below a depth of 39 inches; low relief.	Nearly level relief on stream benches; sand and gravel at a depth of about 3 feet.
Saude: 177A, 177B, 284A, 284B.	Good in upper 12 inches, fair between depths of 12 and 24 inches, poor below.	Good below a depth of about 2 feet; well-graded fine to coarse sand and some gravel.	Fair below a depth of about 2 feet: small amount of gravel; contains too many fines in places.	Not suitable	Good below a depth of about 2 feet: low compressibility; good workability; little or no volume change with moisture.	Highly organic surface layer; fair bearing capacity and shear strength in upper 2 feet; good bearing capacity and shear strength below a depth of 2 feet.	Substratum too porous to hold water.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Shallow to fractured bedrock; limited material available; good stability; easily compacted to high density; moderate volume change with moisture.	Well drained	Shallow to limestone bedrock that may hinder construction.	Shallow to limestone that may hinder construction; easy to vegetate.	Limestone bedrock at a depth of about 2 feet.	Severe: shallow to fractured limestone; danger of contamination.	Severe: shallow to fractured limestone; danger of contamination.
Good stability; poor resistance to piping.	Well drained	Not needed	Generally not needed; easy to vegetate.	Fair to good bearing capacity and shear strength to a depth of 3 feet; good bearing capacity and shear strength below a depth of 3 feet; very low compressibility; negligible volume change with moisture.	Slight: moderate danger of contamination.	Severe: substratum too porous to hold water; moderate danger of contamination.
Good stability; little volume change with moisture below a depth of 2 feet; poor resistance to piping.	Well drained	Generally not needed; short slopes; deep cuts expose coarse material.	Easy to vegetate unless cuts expose coarse material.	Fair to good bearing capacity and shear strength above a depth of 2 feet; good bearing capacity and shear strength below a depth of 2 feet; low compressibility; negligible volume change with moisture.	Slight: moderate danger of contamination.	Severe: substratum too porous to hold water; severe danger of contamination.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of— Topsoil	Sand	Gravel	Limestone	Road fill	Soil features affecting— Highway location [1]	Farm ponds — Reservoir areas
Schley: 407B	Good in upper 6 inches, fair to a depth of about 3 feet, poor below.	Not suitable	Not suitable	Not suitable	Fair: seasonal water table at a depth of 1½ to 2 feet; medium to low compressibility; variable materials to a depth of 3 feet; material below a depth of about 3 feet easily compacted to high density.	Fair to good bearing capacity and fair shear strength; seasonal high water table; highly susceptible to frost action where pockets of water bearing sand occur.	Sand lenses and pockets in many places; slow permeability if compacted.
Sogn: 412B, 412D, 412F.	Poor: shallow to bedrock.	Not suitable	Not suitable	Good: limestone suitable for crushing below a depth of 1 foot.	Good: level-bedded, fractured limestone bedrock at a depth of about 1 foot is good if crushed.	Gently sloping to steep relief; shallow to limestone bedrock.	Shallow to bedrock; too porous to hold water.
Sparta: 41A, 41B, 41C.	Poor: droughty.	Good: poorly graded fine and medium sand.	Poor: gravelly sand below a depth of 2 to 3 feet in a few places on benches.	Not suitable	Good: good workability; very low compressibility; low volume change with moisture.	Highly erodible; seepage possible in some cuts on uplands; good bearing capacity and shear strength; loose sand may hinder hauling.	Too porous to hold water; rapid to very rapid permeability.
*Spillville: 485, 585, 615. For Colo part of units 585 and 615, see Colo series.	Good to a depth of 3 to 4 feet.	Not suitable	Not suitable	Not suitable	Poor: medium to high compressibility; high content of organic material; difficult to compact to high density.	Highly organic surface layer; subject to occasional flooding; poor bearing capacity and fair shear strength; seasonal high water table.	Nearly level relief; highly organic surface layer; subject to flooding.

See footnote at end of table.

properties of the soils—Continued

Soil eatures affecting—Continued					Limitations of soil for—	
Farm ponds—Continued Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Good to fair stability; can be compacted to high density; fair resistance to piping; variable material to a depth of 3 feet.	Seasonal high water table; moderate permeability; drainage designed to intercept seepage is most likely to be successful.	Not all areas need terraces or diversions, but if installed, a combination of terraces and tiling may be the most successful.	Seepy and wet; needs drainage to establish vegetation.	Seasonal water table at a depth of 1½ to 2 feet; fair bearing capacity and shear strength; uneven consolidation possible.	Severe: seasonal high water table.	Moderate: stratified with coarse material.
Available fill material very limited; limestone bedrock at a depth of about 1 foot.	Somewhat excessively drained.	Limestone bedrock at a depth of 12 to 18 inches; bedrock interferes with construction.	Limestone bedrock at a depth of 12 to 18 inches.	Limestone bedrock at a depth of about 1 foot.	Severe: very shallow to fractured limestone.	Severe: very shallow to fractured limestone.
Fair stability; poor resistance to piping; highly erodible; low volume change with moisture.	Excessively drained.	Highly erodible; ridges and channels difficult to maintain; slopes unstable; loose sand may hinder construction.	Highly erodible; difficult to vegetate.	Good bearing capacity and shear strength; very low compressibility; if soil material is wet it may liquify during excavation.	Slight where slope is less than 5 percent, moderate where slope is 5 to 9 percent: rapid to very rapid permeability; severe danger of contamination.	Severe: rapid permeability; material too porous to hold water.
Fair stability; highly organic surface layer; poor resistance to piping.	Subject to some flooding; moderately well drained to somewhat poorly drained; tile drainage generally not needed.	Nearly level relief; all features favorable.	Generally not needed; all features favorable.	Subject to occasional flooding; poor bearing capacity and fair shear strength; medium to high compressibility.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding; material semipervious if compacted; moderate to severe danger of contamination.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds: Reservoir areas
Terril: 27A, 27B	Good to a depth of 2 to 2½ feet, fair below.	Not suitable	Not suitable	Not suitable	Poor: medium to high compressibility; high content of organic material; difficult to compact to high density.	Highly organic surface layer; subject to local flooding in nearly level areas.	Highly organic surface layer; moderate permeability; difficult to compact to high enough density to prevent seepage.
Tripoli: 398	Fair in upper 1½ feet, poor below: high water table.	Not suitable	Not suitable	Not suitable	Poor in upper 2 feet, good below: medium to low compressibility; seasonal water table at a depth of 1 to 2 feet.	Highly organic surface layer; seasonal high water table; fair to good bearing capacity and fair shear strength below a depth of about 2 feet; highly susceptible to frost action where water-bearing sand pockets occur.	Slow permeability when compacted; highly organic surface layer; sand lenses and pockets in places.
Turlin, acid variant: 96.	Good to a depth of 2 to 3 feet, fair below.	Not suitable	Not suitable	Not suitable	Poor: medium to high compressibility; high content of organic material; poor bearing capacity; moderate volume change with moisture.	Highly organic surface layer; subject to occasional flooding; poor bearing capacity; fair shear strength; highly susceptible to frost action; seasonal high water table.	Nearly level bottom land; subject to flooding; high content of organic matter.
Wapsie: 777A, 777B, 777C.	Good in upper 12 inches, fair between depths of 12 and 24 inches, poor below.	Good below a depth of about 2 to 2½ feet: well-graded fine to coarse sand that contains some gravel.	Fair below a depth of about 2½ feet: small amount of gravel.	Not suitable	Good below a depth of about 2½ feet: very low compressibility; good workability; little or no volume change with moisture.	Fair bearing capacity and shear strength in upper 6 inches; good bearing capacity and shear strength below; low relief.	Substratum too porous to hold water.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Fair stability; semipervious if compacted; moderate volume change with moisture.	Well drained	All features generally favorable.	All features favorable.	Poor bearing capacity and fair shear strength; medium to high compressibility; subject to local runoff.	Severe: subject to local runoff of high velocity; damage to filter field may occur.	Severe: subject to local runoff; high content of organic matter.
Highly organic surface layer; fair stability; easily compacted to high density; impervious if compacted; moderate volume change with moisture.	High water table; moderately slow permeability.	Not needed; nearly level relief.	Nearly level relief; wet and seepy; needs drainage to establish vegetation.	Seasonal high water table at a depth of 12 to 24 inches; fair bearing capacity and shear strength below a depth of about 2 feet; medium to low compressibility and shear strength; uneven consolidation possible.	Severe: high water table; moderately slow permeability.	Slight: highly organic surface layer; sand pockets in places.
Fair stability; high content of organic matter; poor resistance to piping.	Seasonal high water table; subject to occasional flooding.	Not needed; nearly level bottom land.	Nearly level bottom land; all features favorable.	Subject to occasional flooding; poor bearing capacity; fair shear strength; seasonal high water table; medium to high compressibility.	Severe: subject to occasional flooding; seasonal high water table; flooding may damage filter fields.	Severe: subject to occasional flooding; sand or gravel below a depth of 48 to 70 inches; severe danger of contamination; highly organic surface layer.
Good stability; poor resistance to piping.	Well drained	Generally not needed; short slopes; coarse texture at a depth of about 2 to 2½ feet.	Generally not needed because of topography; sand and gravel at a depth of 2 to 2½ feet.	Fair to good bearing capacity and shear strength above a depth of 2½ feet; good bearing capacity and shear strength below a depth of 2½ feet; very low compressibility.	Slight: moderate danger of contamination.	Severe: substratum too porous to hold water; severe danger of contamination.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds Reservoir areas
Waukee: 178A, 178B.	Good in upper 1½ feet, fair between depths of 1½ and 3 feet, poor below.	Good below a depth of about 3 feet: well-graded fine to coarse sand or well-graded sand and gravel.	Fair below a depth of about 3 feet: well-graded sand and gravel; contains too many fines in places.	Not suitable	Good below a depth of about 3 feet: very low compressibility; good workability; highly organic surface layer; low volume change with moisture.	Highly organic surface layer; good bearing capacity and shear strength below a depth of 3 feet; low volume change with moisture.	Most areas are nearly level stream benches; sand and gravel below a depth of about 3 feet.
Whalan: 207B, 207C.	Fair in upper 1½ feet, poor below; limestone at a depth of about 2 feet.	Not suitable	Not suitable	Good: limestone suitable for crushing below a depth of about 2 feet.	Fair to good in upper 2 feet; bedrock below 2 feet good if crushed.	Fair bearing capacity and shear strength in material above limestone bedrock; upper 2 to 5 feet of limestone is shattered and free; limestone bedrock at a depth of about 2 feet.	Shallow to fractured bedrock.
Winneshiek: 713A, 713B, 713C.	Good in upper 6 to 12 inches, fair between depths of 12 and 36 inches; limestone bedrock below.	Not suitable	Not suitable	Good: limestone at a depth of 2½ to 3 feet suitable for crushing.	Fair in upper 3 feet: medium to low compressibility; bedrock below a depth of 3 feet good if crushed.	Fair to good bearing capacity and shear strength in material above limestone; upper 2 to 5 feet of limestone is shattered and free; bedrock at a depth of 2½ to 3 feet.	Limestone bedrock below a depth of about 2½ to 3 feet; too porous to hold water.

See footnote at end of table.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Good stability; poor resistance to piping.	Well drained	Generally not needed.	All features favorable; generally not needed.	Good bearing capacity and shear strength below a depth of 3 feet and low volume change with moisture.	Slight: moderate hazard of contamination; moderately permeable in upper strata, rapidly permeable below a depth of about 3 feet.	Severe: substratum too porous to hold water; moderate danger of contamination; highly organic surface layer.
Shallow to fractured bedrock; limited amount of material available; good stability; easily compacted to high density; moderate volume change with moisture.	Well drained	Shallow to limestone that may hinder construction.	Shallow to limestone that may hinder construction; easy to vegetate.	No limitation if footing rests on limestone at a depth of about 2 feet.	Severe: shallow to fractured limestone; danger of contamination.	Severe: shallow to fractured limestone; danger of contamination.
Good stability; limited amount of material available; good workability; easily compacted to high density; moderate volume change with moisture.	Well drained	Limestone bedrock below a depth of 2½ to 3 feet may interfere with construction.	Limestone bedrock below a depth of 2½ to 3 feet may interfere with construction; easy to vegetate.	No limitation if footing rests on limestone at a depth of about 2½ to 3 feet.	Moderate: fractured limestone below a depth of 2½ to 3 feet; danger of contamination.	Severe: fractured limestone below a depth of 2½ to 3 feet; danger of contamination.

TABLE 4.—*Interpretations of engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—	
	Topsoil	Sand	Gravel	Limestone	Road fill	Highway location [1]	Farm ponds — Reservoir areas
Winneshiek—Continued 714A, 714B, 714C, 714C2 714D.	Good in upper 6 to 12 inches, fair between depths of 12 and 24 inches, limestone below.	Not suitable	Not suitable	Limestone below a depth of 2 feet suitable for crushing.	Fair in upper 2 feet; medium to low compressibility; bedrock below a depth of 2 feet good if crushed.	Fair bearing capacity and shear strength in material above limestone; upper 2 to 5 feet is shattered and free bedrock; limestone bedrock at a depth of about 2 feet.	Shallow to fractured bedrock; too porous to hold water.
Winneshiek, shaly subsoil variant: 148A.	Good in upper 6 to 12 inches, fair between depths of 12 and 24 inches, poor below.	Not suitable	Not suitable	Thin strata below a depth of 4 feet or more.	Fair in upper 2 feet: medium to low compressibility; shale below a depth of about 2 feet subject to high volume change with moisture.	Seepage in cuts likely; material above shale has fair bearing capacity and shear strength; highly susceptible to frost action; shale at a depth of about 2 feet.	Shallow to very slowly permeable shale; fractured limestone at a depth of 3 to 4 feet in a few places.

[1] Engineers and others should not apply specific values to the estimates given for bearing capacity of soils.

properties of the soils—Continued

Soil features affecting—Continued					Limitations of soil for—	
Farm ponds—Continued: Embankments	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Septic tank absorption fields	Sewage lagoons
Shallow to fractured bedrock; limited amount of material available; good stability; easily compacted to high density; moderate volume change with moisture.	Well drained	Shallow to limestone that may hinder construction.	Shallow to limestone that may hinder construction; easy to vegetate.	No limitation if foundation rests on limestone at a depth of about 2 feet.	Severe: shallow to fractured limestone; danger of contamination.	Severe: shallow to fractured limestone; danger of contamination.
Fair stability; impervious if compacted; high volume change with moisture.	Moderately well drained.	Not needed; nearly level topography.	Generally not needed; easy to vegetate.	Poor bearing capacity and shear strength; high compressibility; shale subject to dangerous volume change when content of moisture changes.	Severe: very slow permeability.	Slight: shale at a depth of about 2 feet; stratified with limestone bedrock in places.

TABLE 5.—*Engineering*

[Tests performed by Iowa State Highway Commission in accordance with standard procedures of the American

Soil name and location	Parent material	Iowa report No. AAD4	Depth	Moisture density [1]		Mechanical analysis [2]	
				Maximum dry density	Optimum moisture	Percentage passing sieve—	
						¾ inch	⅜ inch
			In.	*Lb. per cu. ft.*	*Pct.*		
Cresco loam: 3 miles west and 2 miles north of Davis Corners. (Modal)	Glacial till.	11495	0–8	86	27	----------	----------
		11496	25–40	113	14	100	99
		11497	47–60	115	15	----------	100
Floyd loam: 3 miles east and 2 miles south of Lourdes. (Modal)	Glacial drift.	11498	0–8	80	30	----------	----------
		11499	25–31	126	9	100	99
		11500	42–51	121	12	100	99
Lourdes loam: 1 mile east and ½ mile north of Lourdes. (Modal)	Glacial till.	11492	0–7	100	20	----------	----------
		11493	21–31	110	15	----------	----------
		11494	40–50	115	14	----------	----------
Protivin loam: 1½ miles west and 1½ miles south of Davis Corners. (Modal)	Glacial till.	11489	0–8	84	29	----------	----------
		11490	21–34	114	14	----------	----------
		11491	44–52	114	14	----------	100
Renova loam: 5 miles west and 1 mile north of Protivin. (Modal)	Glacial drift.	11501	1–10	112	12	----------	----------
		11502	14–26	117	14	100	99
		11503	40–49	116	14	----------	100
Riceville loam: 1 mile west of Davis Corners. (Modal)	Glacial till.	11486	0–6	91	24	----------	----------
		11487	20–27	112	16	----------	----------
		11488	42–48	113	16	----------	100

[1] Based on AASHO Designation T99–57, Method A (*1*).

[2] Mechanical analyses according to AASHO Designation T88–57 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material,

test data

Association of State Highway Officials (AASHO). Absence of an entry indicates that no determination was made]

Mechanical analysis [2]—Continued								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Con.				Percentage smaller than—							
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified
								Pct.			
----------	100	93	77	69	51	24	15	48	15	A-7-5(12)	ML
99	98	85	62	56	45	33	28	37	21	A-6(10)	CL
99	98	87	64	55	45	32	25	35	19	A-6(9)	CL
----------	100	91	75	68	51	23	14	60	17	A-7-5(15)	MH
98	96	65	20	16	12	8	7	17	3	A-2-4(10)	SM
98	97	79	46	39	31	22	17	28	14	A-6(3)	SC
----------	100	95	79	70	53	29	19	35	12	A-6(9)	ML-CL
100	99	90	66	58	48	37	32	43	25	A-7-6(13)	CL
100	98	89	65	58	47	35	28	36	20	A-6(10)	CL
----------	100	94	78	69	51	25	15	54	19	A-7-5(14)	MH
100	99	88	64	57	47	35	29	38	22	A-6(11)	CL
99	97	89	66	55	45	33	27	36	20	A-6(10)	CL
100	99	87	60	54	36	15	9	22	4	A-4(5)	ML-CL
98	96	75	47	39	33	23	19	30	13	A-6(3)	SC
99	97	73	45	37	30	21	16	31	14	A-6(3)	SC
----------	100	95	81	71	55	30	21	41	13	A-7-6(9)	ML
100	99	85	61	53	45	36	30	40	22	A-6(10)	CL
99	97	85	62	54	45	33	28	37	22	A-6(10)	CL

including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes of soil.

Soil features affecting highway work[4]

Most of the soils in Howard County formed in friable loamy material about 2 feet thick overlying firm and very firm glacial till. On the lower concave slopes and in drainageways the thickness of the loamy overburden increases to 3 to 4 feet. In an area from Cresco northwest to Lime Springs, the loamy overburden overlies limestone bedrock. In some areas calcareous shale that has thin beds of limestone is encountered. In the northeastern part of Howard County, or approximately the north half of Albion Township, the land surface is more hilly and rolling than in most of the rest of the county and the soil formed in thick deposits of loess over limestone. On the steep breaks to the Upper Iowa River, limestone bedrock crops out in many places.

The glacial till in Howard County has a relatively high in-place density. It is relatively stable at any moisture content and can be compacted readily to high density. The textural composition varies, but when the material is dry there are enough fines and coarse material to provide a firm riding surface with little rebound after loading. The glacial till has good bearing capacity when compacted to maximum practical density.

Water tends to move more rapidly in the loamy overburden than in the till. Consequently, water accumulates at this contact surface and then moves downhill along the contact line. It may come to the surface part way down the slope as a seepy spot, or it may wet a large part of the slope. This high moisture content is likely to make embankment unstable unless it is controlled.

Soils such as the Kenyon, Ostrander, Cresco, Lourdes, Bassett, Readlyn, Racine, and Renova are the dominant soils that formed in the loamy material over glacial till. These soils are mainly loam, clay loam, and sandy clay loam, and they are classified as A–6 or A–4 (CL or SC). Pockets and lenses of sand that in many places are water-bearing are commonly interspersed throughout those areas. Where a road grade cuts through such deposits, and where the loamy overburden overlies the deposits, frost-heaving is likely, unless the soil material is drained or the material above it is replaced with a granular backfill or with the more clayey glacial till subsoils.

The soils of bottom lands formed in recent alluvium washed from uplands. The Colo, Huntsville, Spillville, and Turlin soils have thick organic surface layers that may consolidate erratically under the load of an embankment. These soils are generally classified as A–7 or A–6 (CL, OL, or OH). They have a low in-place density and a high content of moisture. Therefore, if an embankment is to be more than 15 feet high, the soil material should be carefully analyzed to determine if it is strong enough to support the load. Roadways through bottom lands need to be constructed on a continuous embankment that extends above the level of floods.

Limestone and shale underlie the loamy overburden in part of Howard County, and in places they come to the surface. The residual subsoil just above the rock is undesirable for use in the upper subgrade because of its high content of clay and nonuniform characteristics. The dominant soils that have limestone bedrock at a depth of 2 to 3 feet are the Rockton, Winneshiek, Backbone, Sogn, and Whalan soils. In areas where the limestone is not deeply buried below the glacial till or loess, sinkholes have developed, leaving depressions. These sinkholes do not provide enough support for the embankment for roadways or for other structures. Consequently, great care is needed to determine their location and extent during preliminary investigations. Soils of the Jacwin series and of the Winneshiek series, shaly subsoil variant, are underlain by shale at a depth of less than 3 feet. Where shale is exposed to weathering, it becomes plastic and loses its normal in-place density. Where embankments are constructed over sloping areas of shale, care is needed to insure that moisture is not left free to lubricate the surface of the shale and thus create the possibility of a slide. Likewise, if a cut is necessary through shale that has an overburden of glacial material or loess, the cut slope should be flat enough to eliminate a backslope slide when the shaly surface is lubricated by moisture from natural infiltration areas.

The Downs, Fayette, and Port Byron are the dominant soils that formed in a thick layer of loess on uplands. They are classified as A–4 to A–7–6 (ML or CL). These soils have a slightly plastic subsoil and do not make a desirable upper subgrade in cut areas that are wet. These loessial soils crode rapidly if runoff concentrates. Sodding, paving, or check dams may be needed in gutters and ditches to prevent excessive erosion.

The Burkhardt, Dickinson, Hayfield, Lamont, Lawler, Lilah, Marshan, Sattre, Saude, Sparta, Wapsie, and Waukee soils are underlain by sand and gravel at a depth of 1 to 3 feet and are possible sites for obtaining borrow material and for road construction. In the Dickinson, Lamont, and Sparta soils, however, the sand is fine grained and is poorly graded, and lacks gravel. The Hayfield and Marshan soils are potential sources of sand and gravel, but a high water table interferes with excavation in places.

[4] By DONALD A. ANDERSON, soil engineer, Iowa State Highway Commission.

Formation and Classification of the Soils

In this section factors that have affected the formation of the soils in Howard County are described. Also described is the classification of the soils by higher categories. Detailed descriptions of soil profiles considered representative for the series are given in the section "Description of the Soils."

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (a) the physical and mineralogical composition of the parent material, (b) the climate under which the soil has accumulated and existed since accumulation, (c) the plants and animal life on and in the soil, (d) the relief, or lay of the land, and (e) the length of time the forces of soil development have acted on the soil material (*2*).

Climate and vegetation are the active factors in the formation of soil. They act on the parent material that

has accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effect of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of parent material into a soil profile. It may be much or little, but some time is required for horizon differentiation. A long period generally is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

The accumulation of parent material is the first step in the development of a soil. Some of the soils in the county formed as the result of weathering of the bedrock. Most of the soils, however, formed in material that was transported from the site of the parent rock and redeposited at a new location through the action of glacial ice, water, wind, and gravity.

The principal parent materials in Howard County are glacial drift, loess, aluvium, and eolian, or wind-deposited, sand. Much less extensive parent materials are organic deposits and residuum.

Glacial drift is the major parent material in Howard County. It covers nearly 70 percent of the county. It is uniformly covered with a loamy material about 1 to 2 feet thick. On the lower concave slopes and in the waterways, the thickness of the overburden ranges to as much as 40 inches thick. A stone line or bands of pebbles commonly separate the friable loamy overburden from the more dense, firm and very firm loam and clay loam glacial till. Pockets of coarse-textured material may occur within the glacial till in places (fig. 16), and these pockets add to the seepy condition of the soils that formed in glacial till.

Figure 16.—A pocket of sandy material within glacial till.

Soils formed in the glacial material are of the Bassett, Clyde, Coggon, Cresco, Donnan, Floyd, Jameston, Kenyon, Lourdes, Oran, Ostrander, Pinicon, Protivin, Racine, Readlyn, Renova, Riceville, Schley, and Tripoli series. The Clyde, Floyd, and Schley soils, which are downslope and in drainageways, have a loamy overburden that is thicker than that in the other upland soils that derived from glacial material (fig. 17). The till is very firm clay loam in the Cresco, Jameston, Lourdes, Protivin, and Riceville soils, and it is firm and dominantly loam in the Bassett, Coggon, Kenyon, Oran, Ostrander, Pinicon, Racine, Readlyn, Renova, and Tripoli soils. The Donnan soils formed in a silty clay paleosol derived from glacial till.

The first of the glacial advances over Howard County was the Nebraskan Glaciation, which occurred some 750,000 years ago (*3*). It was followed by the Aftonion interglacial period. The Kansan Glaciation is thought to have started about 500,000 years ago.

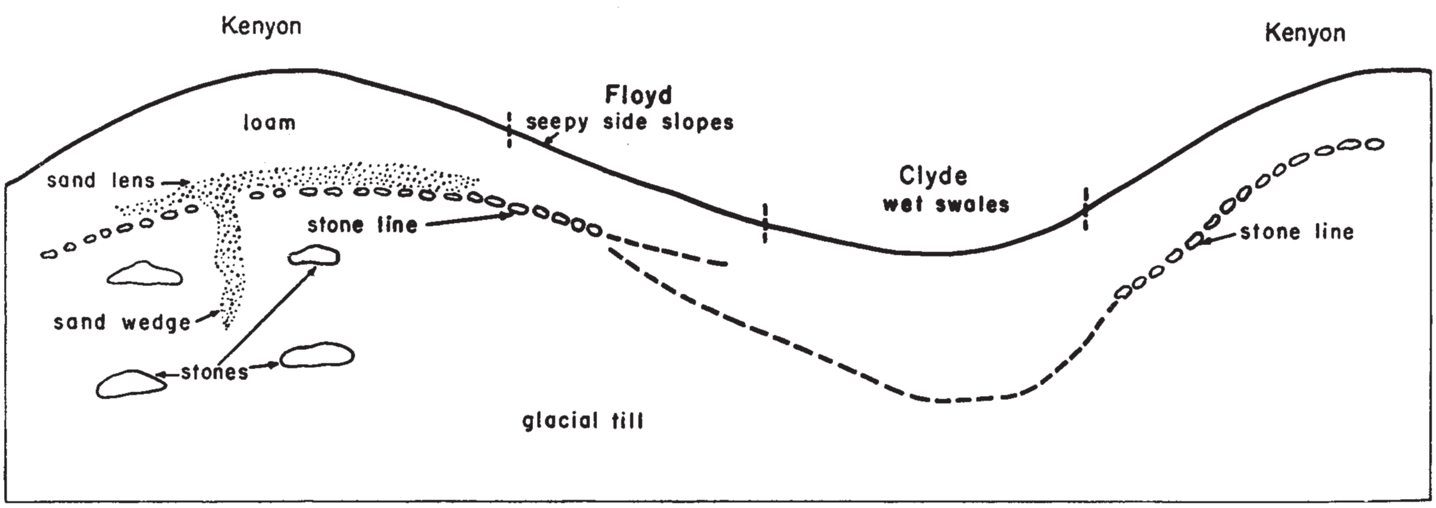


Figure 17.—Parent material of the Kenyon, Floyd, and Clyde soils.

The third and most recent glaciation to advance over Howard County was the Iowa substage of the Wisconsin Glaciation (*4*). Recent studies indicate that the landscape of Howard County is a multilevel sequence of erosion surfaces, and that many of the levels are cut into Kansan and Nebraskan till (*7*).

Boulders 3 to 15 feet in diameter are on the surface in some areas mantled by glacial drift. Boulders and stones 6 to 30 inches in diameter are concentrated in many of the upland drainageways of the Floyd and Clyde soils (fig. 18).

Loess, a silty material deposited by wind, covers only about 4 percent of the county and is dominantly confined to the northeast corner. Loess consists mostly of silt and some clay. It does not contain coarse sand or gravel, because those materials were too large to be moved by wind, but it does contain a small amount of very fine sand. The thickness of the layer of loess in stable areas ranges from a few feet to several feet near the Upper Iowa River.

In Howard County the soils that formed in loess are of the Fayette, Port Byron, and Downs series. These are among the most productive soils in the county, but the land surface is more rolling and hilly than in most of Howard County, especially near the Upper Iowa River (fig. 19).

Alluvium is material that was deposited by water on flood plains along streams. In Howard County about 17 percent of the soils formed in water-laid material. The major areas in which soils formed in alluvium occur along the Upper Iowa River, the Turkey River, the Wapsipinicon River, Crane Creek, and tributaries of these streams. Soils that formed in alluvium generally are stratified and contain layers of sand, silt, or gravel. Much of the alluvium in Howard County washed from the adjoining loamy overburden over glacial drift and has a texture of loam or silty clay loam that is high in content of sand. Examples of these soils are the Ankeny, Colo, Spillville, Terril, and Turlin soils. Some of the soils formed in silty alluvium that washed from the loess-covered upland. Examples of such soils are the Radford and Huntsville soils. All of these soils except Huntsville are on first bottoms and are subject to flooding.

***Figure 18.*—Typical undrained area of Floyd and Clyde soils. A concentration of glacial boulders is in the background.**

***Figure 19.*—Typical landscape of Fayette and Downs soils, which formed in loess.**

Textural differences are accompanied by some differences in chemical and mineralogical composition of the alluvium. For the most part, these soils are free of carbonates and are slightly acid to medium acid. Radford soils, however, are neutral in reaction.

The soils on terraces and second bottoms also formed in alluvium, and they vary in texture. Most are underlain by coarser material within a depth of 2 to 3 feet. They are above the present flood plain and generally are not subject to flooding. They include the Burkhardt, Dickinson, Hayfield, Lamon, Lawler, Lilah, Marshan, Sattre, Saude, Sparta, Wapsie, and Waukee soils.

Eolian sand is wind deposited. It is not extensive in Howard County, but areas do occur along some of the valleys of the major streams. Some occur within the glacial till plain as low mounds or dunes and are underlain by till at various depths. Wind-deposited sand consists largely of very fine and fine particles of quartz which is highly resistant to weathering. It has not been altered since it was deposited. The soils in the county that formed mainly from wind-deposited sand are the Dickinson, Lamont, and Sparta soils.

Limestone and shale residuum is material that derived from the weathering of sedimentary rock in place and is a minor source of parent material in the county. Limestone and shale are the most extensive sedimentary rocks in the county. In most places a deposit of glacial drift or loess covers the residuum, and only in a few places does residuum make up the entire solum. Loam and clay loam deposits are dominant over the limestone and shale, but in a few areas sandy loam material covers the rock. The residuum remaining is commonly only 1 to 10 inches thick. The residuum derived from limestone commonly has a more reddish hue than that from shale.

The soils in Howard County that have a loamy overburden over limestone are of the Backbone, Sogn, Rockton, Whalan, and Winneshiek series. Those that are loamy and underlain by shale are the Jacwin soils and the Winneshiek soils, shaly subsoil variant.

Organic material deposits are the parent material of organic soils (peats and mucks). Organic soils occupy small, wet areas in the county, where poor drainage has

retarded the decay of plant remains that have accumulated over a period of time. In this county the thickness of the organic material ranges from about 10 to 60 inches.

Climate

According to available evidence, the soils of Howard County have been developing under the influence of a midcontinental, subhumid climate for at least 5,000 years. Between 5,000 and 16,000 years ago, the climate was conducive to the growth of forest vegetation (*5*, *12*). The morphology of most of the soils in the county indicates that the climate under which the soils formed is similar to the present one. At present the climate is fairly uniform throughout the county, but is marked by wide seasonal extremes in temperature. Precipitation is evenly distributed throughout the year.

Climate is a major factor in determining the soils that formed in various parent materials. The rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil are influenced by the climate. Temperature, rainfall, relative humidity, and length of the frost-free period are important in determining the vegetation.

The influence of the general climate of the region is somewhat modified by the local conditions in or near the developing soil. For example, dry, sandy soils that have south-facing slopes have a local climate, or microclimate, that is warmer and less humid than the average climate of nearby areas. Low-lying, poorly drained areas are wetter and colder than most areas around them. These contrasts account for some of the differences in soils within the same general climatic region.

Plant and animal life

Plant and animal life are important factors in soil formation. Plant life is especially significant. Soil formation really begins with the coming of vegetation. As plants grow and die, their remains add organic matter to the upper layers of soil material. The native grasses have a myriad of fibrous roots that penetrate 10 to 20 inches into the soil; thus, a large amount of organic matter is in the surface layer. Trees commonly feed on plant nutrients from deep in the subsoil. Consequently, there is little accumulation of organic matter in the surface layer other than what is gained from falling leaves and dead trees. Much of the organic matter from dead leaves and trees remains on the surface or is lost through decomposition.

The Kenyon, Cresco, and Waukee soils are typical of the soils that formed under prairie vegetation in Howard County. Clyde soils are representative of soils that formed under prairie grasses and water-tolerant plants. The Renova and Fayette soils are typical of soils that formed under forest vegetation. Racine and Downs soils have properties that are intermediate between those soils that formed entirely under prairie vegetation and those that formed entirely under trees. Soils that formed under forest vegetation have a thin (typically less than 5 inches thick) dark surface layer. They have a lighter colored layer immediately below the surface layer. In contrast, soils that formed under prairie vegetation contain a large amount of organic matter from roots. As a result, soils that formed under prairie vegetation have a thick dark surface layer.

The Ostrander, Racine, and Renova soils are members of a biosequence, which is a group of soils that formed from the same parent material under comparable environment except for native vegetation. The native vegetation has caused the main differences in morphology among the soils in this group.

Activities of burrowing animals and insects have some effect in loosening and aerating the upper few feet of the soil. The removal of trees by man and the subsequent cultivated crops tend to give some soils a dark surface layer that is somewhat thicker. In some sloping areas, however, cultivation followed by erosion has removed much of the dark surface layer.

Relief

Relief significantly influences differences among soils. Indirectly, it influences soil formation through its effect on drainage. In Howard County the relief ranges from level to steep. Many nearly level areas are flooded frequently and have a high or periodically high water table. On stronger slopes, much of the rainfall runs off.

In general, the soils in Howard County that formed under a high or periodically high water table have a dominantly olive-gray subsoil. Examples are the Colo, Clyde, Marshan, and Tripoli soils. Those soils that formed where the water table was below the subsoil have a yellowish-brown subsoil. Examples are the Downs, Fayette, Port Byron, Ostrander, and Renova soils. Such soils as the Floyd, Readlyn, Oran, and Lawler formed where natural drainage was intermediate; therefore the subsoil is grayish brown in color and is mottled. Of the soils that formed under prairie vegetation, those that have a high water table generally have more organic matter in the surface layer than those that have good natural drainage.

Aspect, as well as gradient, has significant influence. South-facing slopes generally are warmer and drier than north-facing slopes and consequently support a different kind and amount of vegetation.

The influence of a porous, rapidly permeable parent material may override the influence of topography. Dickinson soils, for example, are somewhat excessively drained, although they are no more than moderately sloping, because they are rapidly permeable.

The Tripoli, Readlyn, and Kenyon soils are examples of soils that formed in the same kind of parent material and under similar vegetation but that differ because of differences in topographic position. The Tripoli soils are on broad, level or nearly level upland flats. Readlyn soils are on nearly level ridges and long, gentle, convex side slopes. Kenyon soils are on long, convex ridges and gentle or moderately convex side slopes. Topography influences the drainage of these soils.

Terril soils are on foot slopes and in some narrow upland waterways. They have properties related to the soils upslope from which they receive sediment.

Sogn soils are on steep slopes and have very little soil development. Most of the water that falls on their surface layer runs off rather than through the soil.

Time

Time is necessary for the various processes of soil formation to take place. The amount of time necessary ranges from a few days for the formation of soils in fresh allu-

vial deposits to thousands of years for the paleosols that make up the subsoil of the Donnan soils. In general, if other factors are favorable, the texture of the subsoil becomes finer and a greater amount of soluble materials are leached out as the soils continue to weather. Exceptions are soils that formed in quartz and sand, such as the Sparta soils, or other materials that are resistant to weathering, because such soils do not change much over a long period. Other exceptions are soils that have steep slopes and, therefore, have a small amount of water infiltration and are subject to a large amount of runoff. Such soils weather more slowly than soils on a stable, less sloping landscape.

When organic materials, such as trees, have been buried by later deposition through the action of ice, water, or wind, the age of a landscape can be determined by radiocarbon dating (*6*).

The loess that covers the northeast corner of Howard County, in which the Fayette, Downs, and Port Byron soils formed, is probably about 14,000 to 20,000 years old. The maximum age for these soils on stable summits would be 14,000 years (*5, 6*). Recent studies by Ruhe, Dietz, Fenton, and Hall (*7*) show that the Iowan erosion surface formed during the time of loess deposition. Radiocarbon dating shows this to be between 14,000 and 20,000 years ago. The Iowan surface beneath the loess could be as young as 14,000 years, which dates the close of the major loess deposition in Iowa. The surface can also be younger than the loess. The Iowan surface, where covered by loam sediment, is less than 14,000 years old (*7*). It is this erosion surface with loam sediment on which nearly 70 percent of the soils in Howard County formed. Such soils as the Kenyon, Cresco, Lourdes, Bassett, Racine, Renova, Ostrander, Pinicon, Tripoli, Riceville, and Readlyn are on this surface. Soils such as the Floyd, Clyde, and Schley are younger, as they are cut in and below these higher lying soils.

Radiocarbon dates would interpret some of the surfaces in Howard County to be as young as 2,000 to 6,000 years (*7*). This probably accounts for the weakly developed profile in the Floyd, Schley, and Clyde soils.

Time is needed for soil formation, but the age of the parent material does not necessarily reflect the true age of the soil profile on that material.

Man's influence on the soil

Important changes take place in the soil when it is drained and cultivated. Some of these changes have little effect on soil productivity; others have a major effect. Changes caused by erosion generally are the most apparent. On many of the cultivated soils in the county, particularly on the steeper soils, a part or all of the original surface layer has been lost through sheet erosion. Even in fields that are not eroded, the compaction of the soil by heavy machinery during cultivation reduces the thickness of the surface layer.

Man has done much to increase productivity of the soil and to reclaim areas not suitable for crops. For example, tile drainage has been installed in many places in the county and thus lowering the water table sufficiently so that the areas can be cropped. Through the use of commercial fertilizer, man has been able to counteract deficiencies in plant nutrients to increase the productivity of the soils. To date, most of the soils in Howard County have not been seriously affected by erosion, mainly because much of the county is of low relief, and past cropping patterns have included a fairly high percentage of grass in the rotation.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge to farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories, so that information can be applied to large geographic areas.

The system currently used for classifying soils in the United States was adopted by the National Cooperative Soil Survey in 1965. It is under continual study (*10*).

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Some of the soils of this county do not fit in a series that has been recognized in the classification system, but recognition of a separate series would not serve any useful purpose. Such soils differ from series for which they are named in ways too small to be of consequence in interpreting their usefulness or behavior. They are designated as taxadjuncts to the series for which they are named. In Howard County soils in the Ankeny, Donnan, Hayfield, Sattre, and Sogn series are taxadjuncts to those series.

Table 6 shows the classification of each soil series of Howard County by family, subgroup, and order, according to the current system.

ORDERS: Ten soil orders are recognized in the classification system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the oil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates.

Table 6 shows the two orders in Howard County—Alfisols and Mollisols. Alfisols have a clay-enriched B horizon that is high in base saturation. Mollisols have a thick surface layer that is darkened by organic matter.

SUBORDERS: Each order is divided into suborders, primarily on the basis of those characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of wetness, or soil differences resulting from the climate or vegetation.

GREAT GROUPS: Soil suborders are divided into great groups on the basis of uniformity in the kinds and se-

TABLE 6.—*Classification of the soil series by higher categories*

Series	Family	Subgroup	Order
Ankeny [1]	Coarse-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Backbone	Coarse-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Bassett	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Burkhardt	Sandy, mixed, mesic	Typic Hapludolls	Mollisols.
Clyde	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Coggon	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Colo	Fine-silty, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Cresco	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Dickinson	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Donnan [2]	Fine-loamy over clayey, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Downs	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Fayette	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Floyd	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Hayfield [3]	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Huntsville	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Jacwin	Fine-loamy over clayey, mixed, mesic	Aquic Hapludolls	Mollisols.
Jameston	Fine-loamy, mixed, mesic	Typic Argiaquolls	Mollisols.
Kenyon	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Lamont	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Lawler	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Aquic Hapludolls	Mollisols.
Lilah	Sandy, mixed, mesic	Psammentic Hapludalfs	Alfisols.
Lourdes	Fine-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Marshan	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Haplaquolls	Mollisols.
Oran	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Ostrander	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Pinicon	Fine-loamy, mixed, mesic	Aeric Ochraqualfs	Alfisols.
Port Byron	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Protivin	Fine-loamy, mixed, mesic	Aquic Argiudolls	Mollisols.
Racine	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Radford	Fine-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Readlyn	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Renova	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Riceville	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Rockton	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Sattre [4]	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Mollic Hapludalfs	Alfisols.
Saude	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Hapludolls	Mollisols.
Schley	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Sogn [5]	Loamy, mixed, mesic	Lithic Haplustolls	Mollisols.
Sparta	Sandy, mixed, mesic	Entic Hapludolls	Mollisols.
Spillville	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Terril	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Tripoli	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Turlin, acid variant	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Wapsie	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Mollic Hapludalfs	Alfisols.
Waukee	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Whalan	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Winneshiek	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Winneshiek, shaly subsoil variant.	Fine-loamy over clayey, mixed, mesic	Mollic Hapludalfs	Alfisols.

[1] Those areas that are medium acid below a depth of 12 inches are considered taxadjuncts to the Ankeny series.

[2] In many areas the argillic horizon does not start in the IB horizon, and for that reason these soils are taxadjuncts to the Donnan series.

[3] Mapping units will fit both Aquollic Hapludalfs and Udollic Ochraqualfs. Those units that are gray enough to qualify as Udollic Ochraqualfs are taxadjuncts to the Hayfield series.

[4] Many of these soils have a thick B3 horizon of sandy loam and lack contrasting textures. They are considered to be taxadjuncts to the Sattre series.

[5] These soils have a more favorable moisture relationship than is typical, and they are considered to be taxadjuncts to the Sogn series.

quence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly of calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 6 because it is the last word in the name of the suborder.

SUBGROUPS: Great groups are divided into subgroups, one representing the central (typic) segment of the group, and the others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order.

FAMILIES: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. The family name consists of a series of adjectives preceding the subgroup name. An example is the fine-loamy, mixed, mesic family of Typic Hapludalfs.

SERIES: The series consists of a group of soils that formed from a particular kind of parent material and have genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at state, regional, and national levels of responsibility for soil classification results in a judgment that the new series should be established. All of the soil series described in this survey have been established.

General Nature of the County

This section is primarily for those who are not familiar with Howard County. It discusses the transportation, industry, and recreation of the county as well as general farming, relief and drainage, and climate.

The county is mainly rural, and its few industries, most of them in Cresco, are farm connected. Several small creameries and a large powdered-milk plant are in Cresco. In addition, there are a few small industrial plants. Most towns have hog-buying stations and grain elevators.

U.S. Highway No. 63, the main north-south route in the county, insersects State Highway No. 9, the main east-west route, near the center of the county at Davis Corners. These main highways are connected with all parts of the county by State Highways Nos. 139 and 272 or by good county roads of asphalt, crushed rock, or gravel.

Bus transportation is available on the two main highways, and motor freight lines serve every trading center in the county. Main line railroads service the towns of Chester, Lime Springs, Cresco, Riceville, and Elma. There is a small municipal airport at Cresco and a few private airports in other parts of the county. Scheduled airline transportation is available at nearby Rochester or Waterloo.

Nearly every city, town, and village has a local park. Artificial lakes are on the Turkey River at Vernon Springs and on the Upper Iowa River at Lime Springs, and Lake Hendricks, another artificial lake, is north of Riceville.

In rural areas several small rivers and numerous creeks provide hunting, fishing, and other forms of outdoor recreation. A very scenic area is along the Upper Iowa River from Chester to the eastern edge of the county. Much of this area can be travelled by canoe. From Vernon Springs east along the Turkey River, the landscape is also hilly and picturesque. Howard County supports many kinds of wildlife that contribute to its recreation and to its economy. Pheasants are hunted throughout the county.

Farming

Although the trend in recent years has been toward a decrease in the number of farms in the county, the size of individual farms generally has increased. Livestock farms far outnumber all other types.

The county had a total of 1,296 farms in 1967, according to the Iowa Annual Farm Census. In the same year, 291,805 acres was in farms and the average size of the farms was 225 acres. Most of the acreage that is added to farms consists of formerly wet areas that have been tile drained and made suitable for cultivated crops.

According to the 1967 census, 59.6 percent of the land in Howard County was owner operated and 40.4 percent was operated by tenants. The percentage of owner-operated farms in Howard County is higher than that of the State on the average. The average for the State was 50.6 percent in 1967.

Except for soybeans, most field crops grown in the county are fed to livestock. Some corn is sold as a cash crop, but the amount sold varies from year to year and depends largely on the price of feeder cattle, the market for fat cattle, the market for hogs, the cash price for corn, and the quality of the corn crop. Although corn is the principal grain crop, the acreage in soybeans has increased in the last few years. The acreage of various grain crops in Howard County in 1967 was: corn for all purposes—88,570 acres; oats—25,334 acres; soybeans for beans—42,363 acres; and hay—32,818 acres.

Dairy cattle, beef cattle, and hogs are the livestock most extensively raised in Howard County. In 1967 there were 11,443 milk cows and 9,218 beef cows that were 2 years or older; 3,513 lambs were born; 17,315 sows were farrowing; 98,682 hogs were marketed; 8,925 grain-fed cattle were marketed; and 2,240 grain-fed sheep and lambs were marketed.

Relief and Drainage

Howard County, located in the northernmost tier of Iowa counties and third westward from the Mississippi River, slopes to the southeast.

Most of the soils in the county are level to gently sloping. Slopes are generally long, and a system of drainageways and small streams is well established. The gently sloping to rolling relief in the northeastern part of the county and to the north and south of Cresco is in strong contrast to that in the rest of the county.

The Upper Iowa River zigzags along the northern edge of the county and drains about one-fourth of it. The Turkey River and its tributaries drain the central and east-central parts of the county. The southeastern corner is drained by the Little Turkey River and its tributaries. Crane Creek, the Wapsipinicon River, and the Little Wapsipinicon River flow in a southeasterly direction and drain about the southwestern third of the county.

Climate [5]

Because of its inland location, Howard County has a stimulating continental climate. The summers are warm and the winters are cold, but prolonged periods of intense cold or of intense heat are rare. Table 7 gives temperature and precipitation data for Cresco, which is near the center of the eastern border of the county.

Annual precipitation, increasing eastward, ranges from about 31.2 to 31.8 inches, more than 70 percent of which falls from April through September. Annually, about 185 days have a trace or more of precipitation, 100 have 0.01 inch, 60 have 0.10 inch, and 20 have 0.50 inch or more. Most of the heavier showers occur in spring and early in summer, when the soils in newly tilled fields or in fields with emerging crops are more susceptible to erosion.

An inch or more of snow covers the ground 75 to 90 days per year. The snow season, on the average, begins late in November and ends late in March. In January 1947 the snow cover was 22 inches deep, and in March 1962 it was 21 inches deep. The average annual snowfall is about 40 inches and accounts for about 12 to 15 percent of the annual precipitation.

Except in the surface layer, the soils generally have abundant moisture during the planting season, but the amount varies frequently. May and June are generally the wettest months. They are followed by drier, sometimes too dry, weather during July and August. Corn requires about an inch of available moisture per week for optimum growth; however, an inch of rain generally is received in only 2 out of 5 weeks during the latter half of the May-June period and in only 1 out of 3 or 4 weeks during July and August. Hence, an abundance of moisture in the subsoil at the beginning of the cropping season is highly desirable.

Although temperatures have ranged from −45° to 106° F., the number of days too hot for corn (equal to or about 90°) usually is not in excess of 10 or 12 days per year. On calm, clear nights the difference in temperature between the cool rural lowlands and the warmer city locations or upland areas is likely to be as much as 10 to 20 degrees.

Generally, the last freezing temperature in spring occurs early in May. The first freezing temperature in fall can be expected about the first of October. The growing season is about 140 to 150 days.

[5] By PAUL J. WAITE, climatologist for Iowa, National Weather Service, U.S. Department of Commerce.

TABLE 7.—*Temperature and precipitation*

[Data recorded at Cresco, Iowa]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average highest maximum	Average lowest minimum	Average total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Number of days with snow cover of 1.0 inch or more	Average depth of snow on days with snow cover
	°F.	°F.	°F.	°F.	Inches	Inches	Inches		Inches
January	25	6	42	−20	1.1	0.1	2.2	25	5
February	29	11	44	−14	1.0	(1)	2.1	20	5
March	40	21	60	−3	2.0	.8	4.5	14	6
April	57	35	76	20	2.6	1.1	5.9	1	2
May	69	46	83	30	4.0	2.1	5.9	0	0
June	78	56	91	43	4.9	1.8	7.8	0	0
July	84	60	93	49	4.0	1.5	8.5	0	0
August	82	59	93	40	3.7	1.8	8.6	0	0
September	73	50	88	29	3.5	1.1	5.6	0	0
October	62	40	79	23	2.2	.1	4.3	0	0
November	43	25	65	4	1.6	.2	3.3	4	3
December	27	13	47	−11	1.2	.3	2.0	17	4
Year	58	35	95	−21	31.8	24.2	45.6	81	5

[1] Trace.

Literature Cited

(1) American Association of State Highway Officials.
1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 v., illus.

(2) Jenny, Hans.
1941. Factors of soil formation. 281 pp., illus. New York and London.

(3) Kay, G. F., and Apfel, E. T.
1929. The pre-Illinoian Pleistocene geology of Iowa. Iowa Geol. Survey Ann. Rpt. (1928), 34: 1–304, illus.

(4) Leighton, M. M.
1933. The naming of the subdivisions of the Wisconsin glacial age. Science (New Ser.), v. 77, p. 168.

(5) Ruhe, R. V.
1956. Geomorphic surfaces and the nature of soils. Soil Sci. 82: 441–455.

(6) ——— Rubin, Meyer, and Scholtes, W. H.
1957. Late Pleistocene radiocarbon chronology in Iowa. Amer. Jour. Sci. 255: 671–689.

(7) ——— Dietz, W. P., Fenton, T. E., and Hall, G. F.
1968. Iowan drift problem of northeastern Iowa. Iowa Geol. Survey Rept. of Investigation 7, 1–40, illus.

(8) Schnur, G. Luther.
1937. Yield, stand, and volume tables for even-aged upland oak forests. U.S. Dept. Agr., Tech. Bul. No. 560, 87 pp., illus.

(9) United States Department of Agriculture.
1951. Soil survey manual. U.S. Dept. Agr. Handbook 18, 503 pp., illus.

(10) ———
1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued March 1967 and September 1968].

(11) United States Department of Defense.
1968. Unified soil classification system for road, airfields, embankments and foundations. MIL–STD–619B, 30 pp., illus.

(12) Walker, P. H.
1966. Postglacial environments in relation to landscape and soils on the Cary drift, Iowa. Res. Bul. 549, Iowa Agric. and Home Econ. Expt. Sta., Iowa State Univ., Ames, Iowa, pp. 838–875.

Glossary

Acidity. (See Reaction, soil)

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Alluvium, local. Soil material that has been moved a short distance and deposited at the base of slopes and along small drainageways. It includes the poorly sorted material near the base of slopes that has been moved by gravity, frost action, soil creep, and local wash.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Bench position. A high, shelf-like position.

Bottom, first. The normal flood plain of a stream; land along the stream subject to flooding.

Bottom, second. An old alluvial plain. generally flat or smooth, that borders a stream but is seldom flooded.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour tillage. Cultivation that follows the contour of the land, generally almost at right angles to the slope.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A horizon and upper part of the B horizon and have mottling in the lower part of the B and C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Glacial drift (geology). Rock material transported by glacial ice and then deposited. It also includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt-water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed' is applied to soil horizons that have yellow and gray mottling caused by intermittent waterlogging.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the

A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Interfluve. The land between two adjacent streams flowing in the same general direction.

Leaching, soil. The removal of materials in solution by the passage of water through the soil.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Paleosol. An antiquated soil that was formed during the geologic past and was buried and preserved by more recent sedimentation. This kind of buried soil is often reexposed on the modern surface by subsequent erosion. It is then called an exhumed paleosol.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contract to a clod.

Percolation. The downward movement of water through soil.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Relief. Elevations or inequalities of the surface of the land considered collectively.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.5 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

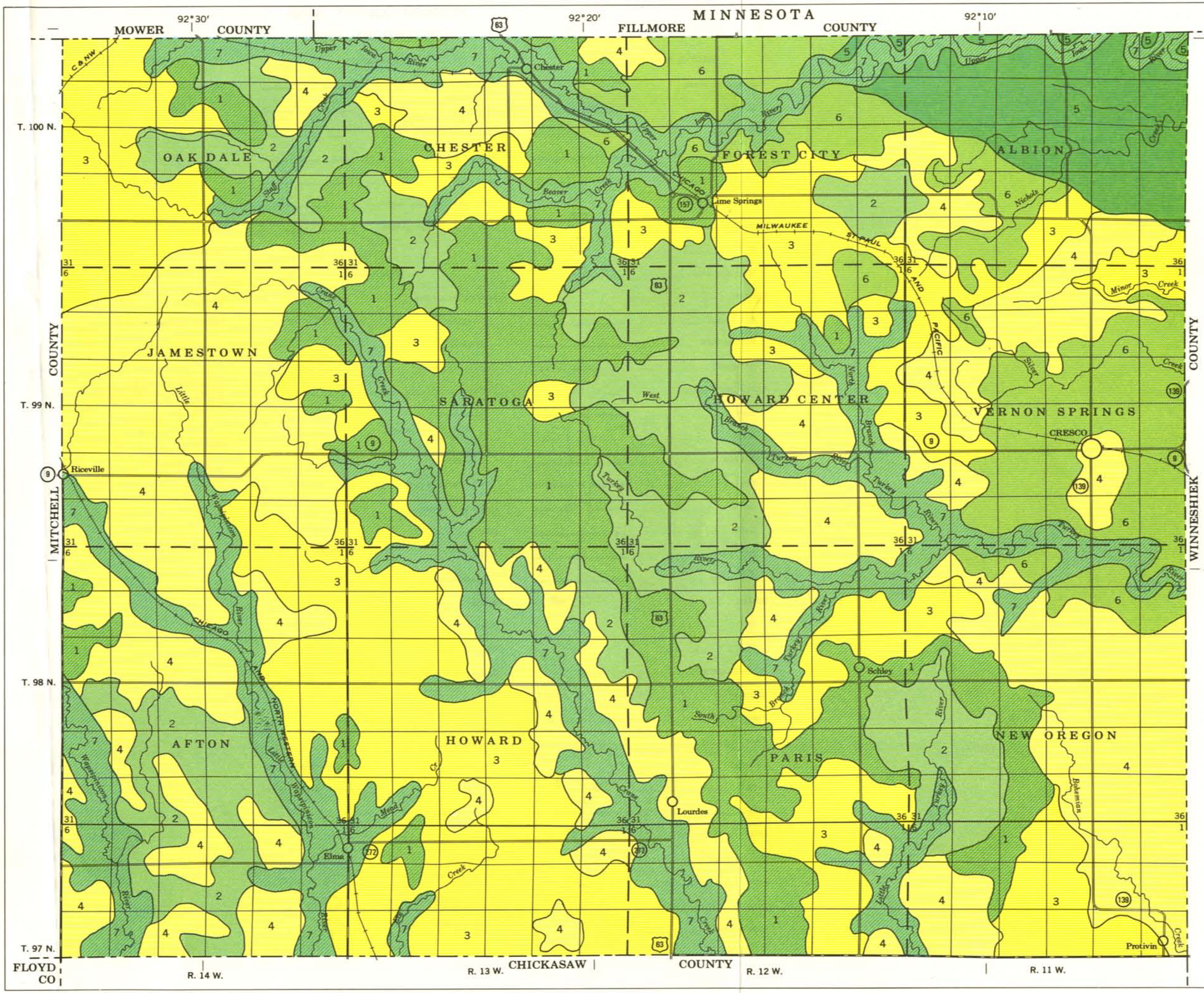
Upland. Land above the lowlands along rivers or between hills.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.



SOIL ASSOCIATIONS *

1 — Cresco-Clyde-Protivin association: Nearly level to gently sloping, moderately well drained to poorly drained, loamy soils on uplands

2 — Clyde-Floyd-Schley association: Nearly level to gently sloping, somewhat poorly drained and poorly drained, loamy soils on uplands

3 — Kenyon-Clyde-Floyd association: Nearly level to moderately sloping, dark-colored, moderately well drained to poorly drained, loamy soils on uplands

4 — Bassett-Clyde-Schley association: Nearly level to moderately sloping, moderately dark colored, moderately well drained to poorly drained, loamy soils on uplands

5 — Downs-Fayette association: Gently sloping to steep, well-drained, loamy soils on uplands

6 — Rockton-Winneshiek association: Nearly level to steep, well-drained, moderately deep and deep, loamy soils on uplands

7 — Saude-Wapsie-Marshan association: Level to gently sloping, well-drained and poorly drained, loamy soils on bottom lands and stream benches

*The texture terms apply to the surface layer of the major soils in each association

Compiled 1972

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

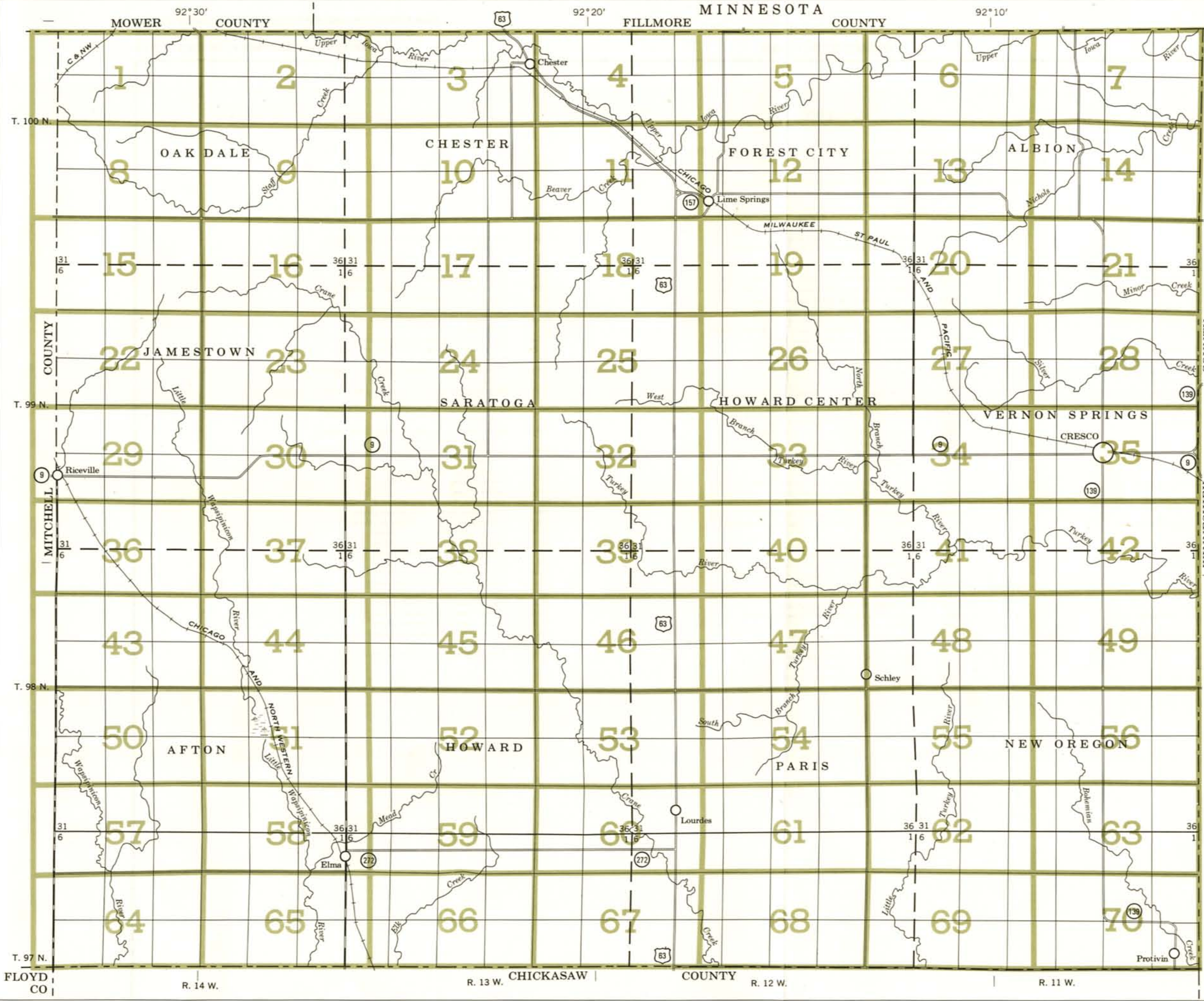
IOWA AGRICULTURE AND HOME ECONOMICS
EXPERIMENT STATION COOPERATIVE
EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION,
STATE OF IOWA

GENERAL SOIL MAP
HOWARD COUNTY, IOWA

Scale 1:126,720

1 0 1 2 3 4 Miles

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

HOWARD COUNTY, IOWA

Scale 1:126,720

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Symbols consist of numbers or a combination of numbers and letters, for example, 84 or 136A. The number designates the soil type, soil complex, or land type. A capital letter, A, B, C, D, E, or F, following a number indicates the slope. Symbols without a slope letter are those of nearly level soils. A final number 2 after the slope letter indicates a moderately eroded soil.

SYMBOL	NAME
21	Muck, shallow
27A	Terril loam, 0 to 2 percent slopes
27B	Terril loam, 2 to 5 percent slopes
41A	Sparta loamy fine sand, 0 to 2 percent slopes
41B	Sparta loamy fine sand, 2 to 5 percent slopes
41C	Sparta loamy fine sand, 5 to 9 percent slopes
83B	Kenyon loam, 2 to 5 percent slopes
83C	Kenyon loam, 5 to 9 percent slopes
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded
84	Clyde silty clay loam
96	Turlin silt loam, acid variant
109B	Backbone fine sandy loam, 2 to 5 percent slopes
109C	Backbone fine sandy loam, 5 to 9 percent slopes
110A	Lamont fine sandy loam, 0 to 2 percent slopes
110B	Lamont fine sandy loam, 2 to 5 percent slopes
110C	Lamont fine sandy loam, 5 to 9 percent slopes
133	Colo silty clay loam, loamy substratum
136A	Ankeny sandy loam, 0 to 2 percent slopes
148A	Winneshiek loam, shaly subsoil variant, 0 to 2 percent slopes
152	Marshan clay loam, deep
153	Marshan clay loam, depressional
162B	Downs silt loam, 2 to 5 percent slopes
162C	Downs silt loam, 5 to 9 percent slopes
162C2	Downs silt loam, 5 to 9 percent slopes, moderately eroded
162D2	Downs silt loam, 9 to 14 percent slopes, moderately eroded
162E2	Downs silt loam, 14 to 20 percent slopes, moderately eroded
163C	Fayette silt loam, 5 to 9 percent slopes
163D	Fayette silt loam, 9 to 14 percent slopes
163E	Fayette silt loam, 14 to 20 percent slopes
163F	Fayette silt loam, 20 to 30 percent slopes
171A	Bassett loam, 0 to 2 percent slopes
171B	Bassett loam, 2 to 5 percent slopes
171C	Bassett loam, 5 to 9 percent slopes
171C2	Bassett loam, 5 to 9 percent slopes, moderately eroded
175A	Dickinson fine sandy loam, 0 to 2 percent slopes
175B	Dickinson fine sandy loam, 2 to 5 percent slopes
177A	Saude loam, 0 to 2 percent slopes
177B	Saude loam, 2 to 5 percent slopes
178A	Waukee loam, 0 to 2 percent slopes
178B	Waukee loam, 2 to 5 percent slopes
195B	Radford and Huntsville silt loams, 2 to 5 percent slopes
198B	Floyd loam, 1 to 4 percent slopes
207B	Whalan loam, moderately deep, 2 to 5 percent slopes
207C	Whalan loam, moderately deep, 5 to 9 percent slopes
213A	Rockton loam, deep, 0 to 2 percent slopes
213B	Rockton loam, deep, 2 to 5 percent slopes
213C	Rockton loam, deep, 5 to 9 percent slopes
214A	Rockton loam, moderately deep, 0 to 2 percent slopes
214B	Rockton loam, moderately deep, 2 to 5 percent slopes
214C	Rockton loam, moderately deep, 5 to 9 percent slopes
214C2	Rockton loam, moderately deep, 5 to 9 percent slopes, moderately eroded
221	Muck, moderately deep
225	Lawler loam, moderately deep
226	Lawler loam, deep
284A	Saude sandy loam, 0 to 2 percent slopes
284B	Saude sandy loam, 2 to 5 percent slopes
285C	Burkhardt sandy loam, 3 to 9 percent slopes
302B	Coggon loam, 2 to 5 percent slopes
303B	Pinicon silt loam, 1 to 4 percent slopes
315	Colo-Alluvial land complex, channeled
354	Marsh
391B	Clyde-Floyd complex, 1 to 4 percent slopes
394A	Ostrander loam, 0 to 2 percent slopes
394B	Ostrander loam, 2 to 5 percent slopes
394C	Ostrander loam, 5 to 9 percent slopes
394C2	Ostrander loam, 5 to 9 percent slopes, moderately eroded
398	Tripoli silty clay loam
399A	Readlyn loam, 0 to 2 percent slopes
399B	Readlyn loam, 2 to 5 percent slopes
407B	Schley silt loam, 1 to 4 percent slopes
412B	Sogn loam, 2 to 5 percent slopes
412D	Sogn loam, 5 to 14 percent slopes
412F	Sogn loam, 14 to 40 percent slopes
444	Jacwin silty clay loam, 0 to 2 percent slopes
467	Radford silt loam
471A	Oran loam, 0 to 2 percent slopes
471B	Oran loam, 2 to 5 percent slopes
482A	Racine loam, 0 to 2 percent slopes
482B	Racine loam, 2 to 5 percent slopes
482C	Racine loam, 5 to 9 percent slopes
482C2	Racine loam, 5 to 9 percent slopes, moderately eroded
485	Spillville loam
491B	Renova loam, 2 to 5 percent slopes
575B	Dickinson-Ostrander complex, 2 to 5 percent slopes
576B	Dickinson-Racine complex, 2 to 5 percent slopes
585	Spillville-Colo complex
615	Spillville-Colo complex, channeled
620B	Port Byron silt loam, 2 to 5 percent slopes
621	Muck, deep
713A	Winneshiek loam, deep, 0 to 2 percent slopes
713B	Winneshiek loam, deep, 2 to 5 percent slopes
713C	Winneshiek loam, deep, 5 to 9 percent slopes
714A	Winneshiek loam, moderately deep, 0 to 2 percent slopes
714B	Winneshiek loam, moderately deep, 2 to 5 percent slopes
714C	Winneshiek loam, moderately deep, 5 to 9 percent slopes
714C2	Winneshiek loam, moderately deep, 5 to 9 percent slopes, moderately eroded
714D	Winneshiek loam, moderately deep, 9 to 14 percent slopes
715	Colo-Alluvial land complex
725	Hayfield loam, moderately deep
726	Hayfield loam, deep
776A	Lilah sandy loam, 0 to 3 percent slopes
776C	Lilah sandy loam, 3 to 9 percent slopes
776D	Lilah sandy loam, 9 to 14 percent slopes
777A	Wapsie loam, 0 to 2 percent slopes
777B	Wapsie loam, 2 to 5 percent slopes
777C	Wapsie loam, 5 to 9 percent slopes
778A	Sattre loam, 0 to 2 percent slopes
781B	Lourdes loam, 2 to 5 percent slopes
781C	Lourdes loam, 5 to 9 percent slopes
782A	Donnan loam, 0 to 2 percent slopes
782B	Donnan loam, 2 to 5 percent slopes
783B	Cresco loam, 2 to 5 percent slopes
783C	Cresco loam, 5 to 9 percent slopes
784B	Riceville loam, 1 to 4 percent slopes
797	Jameston silty clay loam
798B	Protivin loam, 1 to 4 percent slopes

HOWARD COUNTY, IOWA

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads

- Divided
- Good motor
- Poor motor
- Trail

Highway markers

- National Interstate
- U. S.
- State or county

Railroads

- Single track
- Multiple track
- Abandoned

Bridges and crossings

- Road
- Trail
- Railroad
- Ferry — FY
- Ford — FORD
- Grade
- R. R. over
- R. R. under

Buildings

- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line

- Perennial
- Intermittent

Streams, single-line

- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches

Lakes and ponds

- Perennial — water, w
- Intermittent — int

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments

- Bedrock
- Other

Short steep slope

Prominent peak

Depressions (Large, Small)

- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol — Dx
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Clayey subsoil 20 to 40 inches below surface, less than 3 acres
- Glacial till
- Limestone bedrock surface, less than 3 acres
- Muck and peaty muck less than 2 acres

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit or a woodland group, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acreage and proportionate extent, table 1, p. 12.
Predicted yields, table 2, p. 71.

Use of the soils for engineering, tables 3, 4, and 5, pp. 76 through 121.

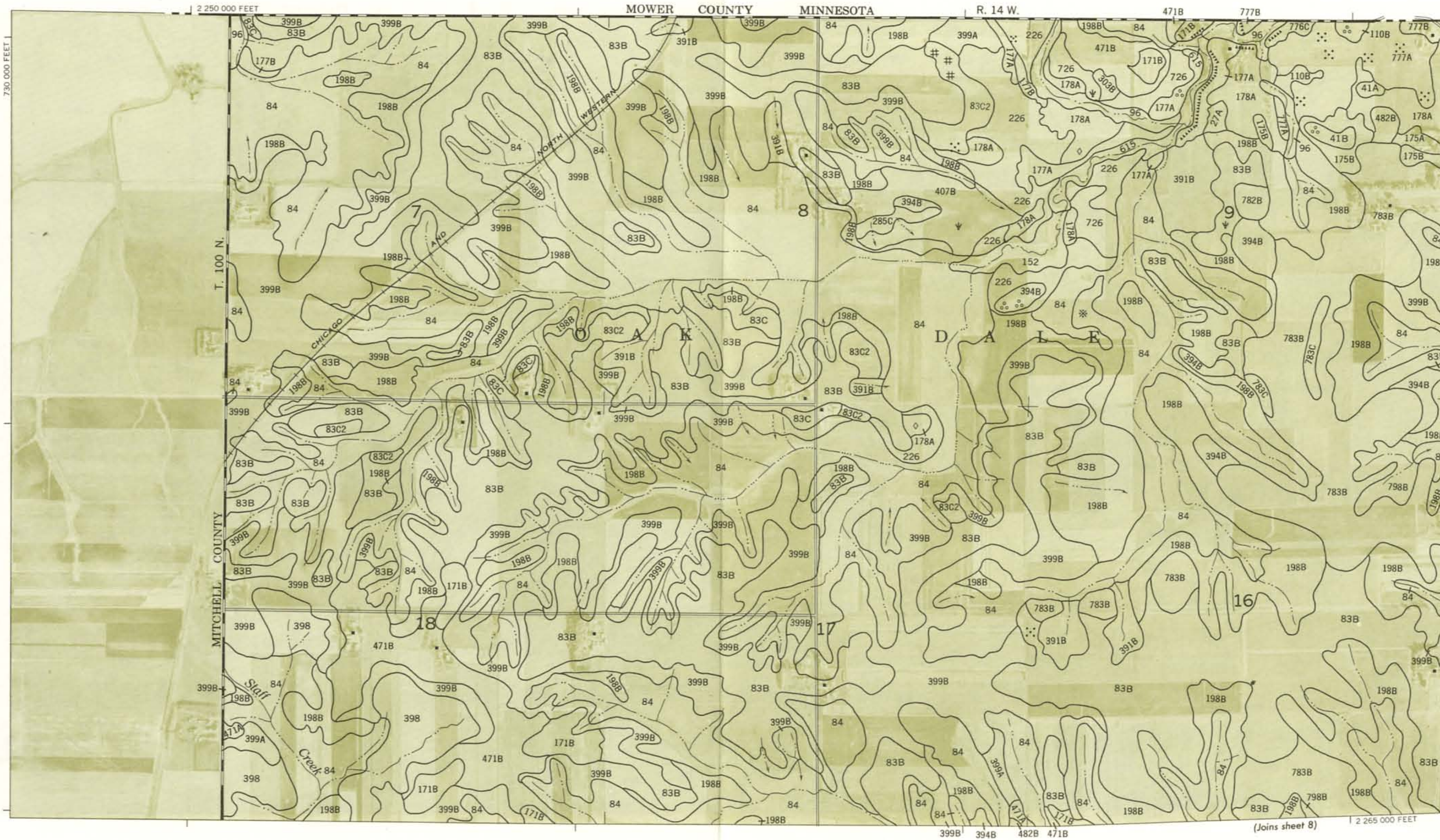
Map symbol	Mapping unit	Page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
136A	Ankeny sandy loam, 0 to 2 percent slopes	13	IIs-2	64	9	74
109B	Backbone fine sandy loam, 2 to 5 percent slopes	14	IIIe-4	65	3	73
109C	Backbone fine sandy loam, 5 to 9 percent slopes	14	IIIe-4	65	3	73
171A	Bassett loam, 0 to 2 percent slopes	15	I-2	62	6	73
171B	Bassett loam, 2 to 5 percent slopes	15	IIe-1	62	6	73
171C	Bassett loam, 5 to 9 percent slopes	15	IIIe-1	64	6	73
171C2	Bassett loam, 5 to 9 percent slopes, moderately eroded	15	IIIe-1	64	6	73
285C	Burkhardt sandy loam, 3 to 9 percent slopes	16	IVs-2	66	1	70
84	Clyde silty clay loam	17	IIw-1	63	10	74
391B	Clyde-Floyd complex, 1 to 4 percent slopes	17	IIw-1	63	10	74
302B	Coggon loam, 2 to 5 percent slopes	18	IIe-1	62	6	73
133	Colo silty clay loam, loamy substratum	19	IIw-4	64	10	74
715	Colo-Alluvial land complex	19	IIIw-3	66	10	74
315	Colo-Alluvial land complex, channeled	19	Vw-1	67	10	74
783B	Cresco loam, 2 to 5 percent slopes	20	IIe-2	62	7	74
783C	Cresco loam, 5 to 9 percent slopes	20	IIIe-2	64	7	74
175A	Dickinson fine sandy loam, 0 to 2 percent slopes	21	IIIs-1	65	3	73
175B	Dickinson fine sandy loam, 2 to 5 percent slopes	21	IIIe-4	65	3	73
575B	Dickinson-Ostrander complex, 2 to 5 percent slopes	21	IIe-4	62	3	73
576B	Dickinson-Racine complex, 2 to 5 percent slopes	21	IIe-4	62	3	73
782A	Donnan loam, 0 to 2 percent slopes	22	IIw-3	63	7	74
782B	Donnan loam, 2 to 5 percent slopes	22	IIe-2	62	7	74
162B	Downs silt loam, 2 to 5 percent slopes	23	IIe-1	62	4	73
162C	Downs silt loam, 5 to 9 percent slopes	23	IIIe-1	64	4	73
162C2	Downs silt loam, 5 to 9 percent slopes, moderately eroded	23	IIIe-1	64	4	73
162D2	Downs silt loam, 9 to 14 percent slopes, moderately eroded	24	IIIe-1	64	4	73
162E2	Downs silt loam, 14 to 20 percent slopes, moderately eroded	24	IVe-1	66	4	73
163C	Fayette silt loam, 5 to 9 percent slopes	25	IIIe-1	64	4	73
163D	Fayette silt loam, 9 to 14 percent slopes	25	IIIe-1	64	4	73
163E	Fayette silt loam, 14 to 20 percent slopes	25	IVe-1	66	4	73
163F	Fayette silt loam, 20 to 30 percent slopes	25	VIe-1	67	5	73
198B	Floyd loam, 1 to 4 percent slopes	26	IIw-2	63	8	74
726	Hayfield loam, deep	27	I-2	62	8	74
725	Hayfield loam, moderately deep	27	IIs-1	64	8	74
444	Jacwin silty clay loam, 0 to 2 percent slopes	28	IIw-3	63	7	74
797	Jameston silty clay loam	29	IIw-1	63	10	74
83B	Kenyon loam, 2 to 5 percent slopes	30	IIe-1	62	6	73
83C	Kenyon loam, 5 to 9 percent slopes	30	IIIe-1	64	6	73
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded	30	IIIe-1	64	6	73
110A	Lamont fine sandy loam, 0 to 2 percent slopes	31	IIIs-1	65	3	73
110B	Lamont fine sandy loam, 2 to 5 percent slopes	31	IIIe-4	65	3	73
110C	Lamont fine sandy loam, 5 to 9 percent slopes	31	IIIe-4	65	3	73
226	Lawler loam, deep	32	I-2	62	8	74
225	Lawler loam, moderately deep	32	IIs-1	64	8	74
776A	Lilah sandy loam, 0 to 3 percent slopes	33	IVs-1	66	1	70
776C	Lilah sandy loam, 3 to 9 percent slopes	33	IVs-2	66	1	70
776D	Lilah sandy loam, 9 to 14 percent slopes	33	VIs-1	67	1	70
781B	Lourdes loam, 2 to 5 percent slopes	34	IIe-2	62	7	74
781C	Lourdes loam, 5 to 9 percent slopes	34	IIIe-2	64	7	74
354	Marsh	34	VIIw-1	67	11	74
152	Marshan clay loam, deep	35	IIw-1	63	10	74

Map symbol	Mapping unit	Page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
153	Marshan clay loam, depressional	35	IIIw-1	65	10	74
621	Muck, deep	36	IIIw-2	65	11	74
221	Muck, moderately deep	36	IIIw-2	65	11	74
21	Muck, shallow	36	IIIw-2	65	11	74
471A	Oran loam, 0 to 2 percent slopes	37	I-2	62	8	74
471B	Oran loam, 2 to 5 percent slopes	37	IIe-3	62	8	74
394A	Ostrander loam, 0 to 2 percent slopes	38	I-2	62	6	73
394B	Ostrander loam, 2 to 5 percent slopes	38	IIe-1	62	6	73
394C	Ostrander loam, 5 to 9 percent slopes	38	IIIe-1	64	6	73
394C2	Ostrander loam, 5 to 9 percent slopes, moderately eroded	38	IIIe-1	64	6	73
303B	Pinicon silt loam, 1 to 4 percent slopes	39	IIw-2	63	8	74
620B	Port Byron silt loam, 2 to 5 percent slopes	40	IIe-1	62	4	73
798B	Protivin loam, 1 to 4 percent slopes	41	IIw-3	63	7	74
482A	Racine loam, 0 to 2 percent slopes	42	I-2	62	6	73
482B	Racine loam, 2 to 5 percent slopes	42	IIe-1	62	6	73
482C	Racine loam, 5 to 9 percent slopes	42	IIIe-1	64	6	73
482C2	Racine loam, 5 to 9 percent slopes, moderately eroded	42	IIIe-1	64	6	73
467	Radford silt loam	43	I-1	61	9	74
195B	Radford and Huntsville silt loams, 2 to 5 percent slopes	43	IIe-5	63	9	74
399A	Readlyn loam, 0 to 2 percent slopes	44	I-2	62	8	74
399B	Readlyn loam, 2 to 5 percent slopes	44	IIe-3	62	8	74
491B	Renova loam, 2 to 5 percent slopes	45	IIe-1	62	6	73
784B	Riceville loam, 1 to 4 percent slopes	46	IIw-3	63	7	74
213A	Rockton loam, deep, 0 to 2 percent slopes	46	I-2	62	6	73
213B	Rockton loam, deep, 2 to 5 percent slopes	47	IIe-1	62	6	73
213C	Rockton loam, deep, 5 to 9 percent slopes	47	IIIe-1	64	6	73
214A	Rockton loam, moderately deep, 0 to 2 percent slopes	47	IIs-1	64	3	73
214B	Rockton loam, moderately deep, 2 to 5 percent slopes	47	IIe-4	62	3	73
214C	Rockton loam, moderately deep, 5 to 9 percent slopes	47	IIIe-3	65	3	73
214C2	Rockton loam, moderately deep, 5 to 9 percent slopes, moderately eroded	47	IIIe-3	65	3	73
778A	Sattre loam, 0 to 2 percent slopes	48	I-2	62	6	73
177A	Saude loam, 0 to 2 percent slopes	49	IIs-1	64	3	73
177B	Saude loam, 2 to 5 percent slopes	49	IIe-4	62	3	73
284A	Saude sandy loam, 0 to 2 percent slopes	49	IIIs-1	65	3	73
284B	Saude sandy loam, 2 to 5 percent slopes	49	IIIe-4	65	3	73
407B	Schley silt loam, 1 to 4 percent slopes	50	IIw-2	63	8	74
412B	Sogn loam, 2 to 5 percent slopes	51	IVs-2	66	1	70
412D	Sogn loam, 5 to 14 percent slopes	51	VIs-1	67	1	70
412F	Sogn loam, 14 to 40 percent slopes	51	VIIs-1	67	1	70
41A	Sparta loamy fine sand, 0 to 2 percent slopes	52	IVs-1	66	2	72
41B	Sparta loamy fine sand, 2 to 5 percent slopes	52	IVs-2	66	2	72
41C	Sparta loamy fine sand, 5 to 9 percent slopes	52	IVs-2	66	2	72
485	Spillville loam	53	I-1	61	9	74
585	Spillville-Colo complex	53	IIw-4	64	9	74
615	Spillville-Colo complex, channeled	53	Vw-1	67	9	74
27A	Terril loam, 0 to 2 percent slopes	54	I-1	61	6	73
27B	Terril loam, 2 to 5 percent slopes	54	IIe-5	63	6	73
398	Tripoli silty clay loam	54	IIw-1	63	10	74
96	Turlin silt loam, acid variant	55	I-1	61	9	74
777A	Wapsie loam, 0 to 2 percent slopes	56	IIs-1	64	3	73

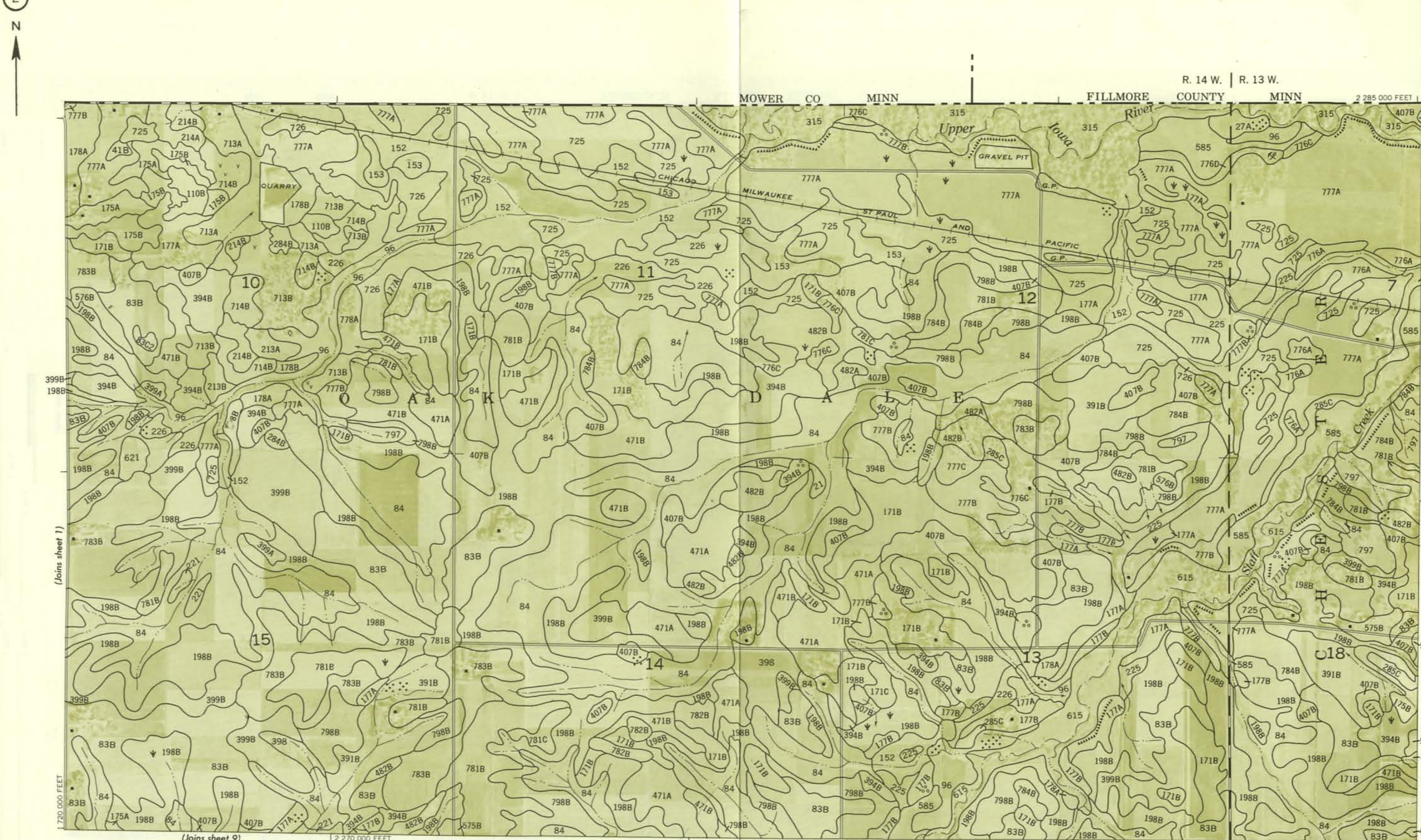
Map symbol	Mapping unit	Page	Capability unit		Woodland suitability group	
			Symbol	Page	Symbol	Page
777B	Wapsie loam, 2 to 5 percent slopes	56	IIe-4	62	3	73
777C	Wapsie loam, 5 to 9 percent slopes	56	IIIe-3	65	3	73
178A	Waukee loam, 0 to 2 percent slopes	57	I-2	62	6	73
178B	Waukee loam, 2 to 5 percent slopes	57	IIe-1	62	6	73
207B	Whalan loam, moderately deep, 2 to 5 percent slopes	57	IIe-4	62	3	73
207C	Whalan loam, moderately deep, 5 to 9 percent slopes	58	IIIe-3	65	3	73
713A	Winneshiek loam, deep, 0 to 2 percent slopes	58	I-2	62	6	73
713B	Winneshiek loam, deep, 2 to 5 percent slopes	59	IIe-1	62	6	73
713C	Winneshiek loam, deep, 5 to 9 percent slopes	59	IIIe-1	64	6	73
714A	Winneshiek loam, moderately deep, 0 to 2 percent slopes	59	IIs-1	64	3	73
714B	Winneshiek loam, moderately deep, 2 to 5 percent slopes	59	IIe-4	62	3	73
714C	Winneshiek loam, moderately deep, 5 to 9 percent slopes	59	IIIe-3	65	3	73
714C2	Winneshiek loam, moderately deep, 5 to 9 percent slopes, moderately eroded	59	IIIe-3	65	3	73
714D	Winneshiek loam, moderately deep, 9 to 14 percent slopes	59	IVe-2	66	3	73
148A	Winneshiek loam, shaly subsoil variant, 0 to 2 percent slopes	60	IIs-1	64	7	74

1

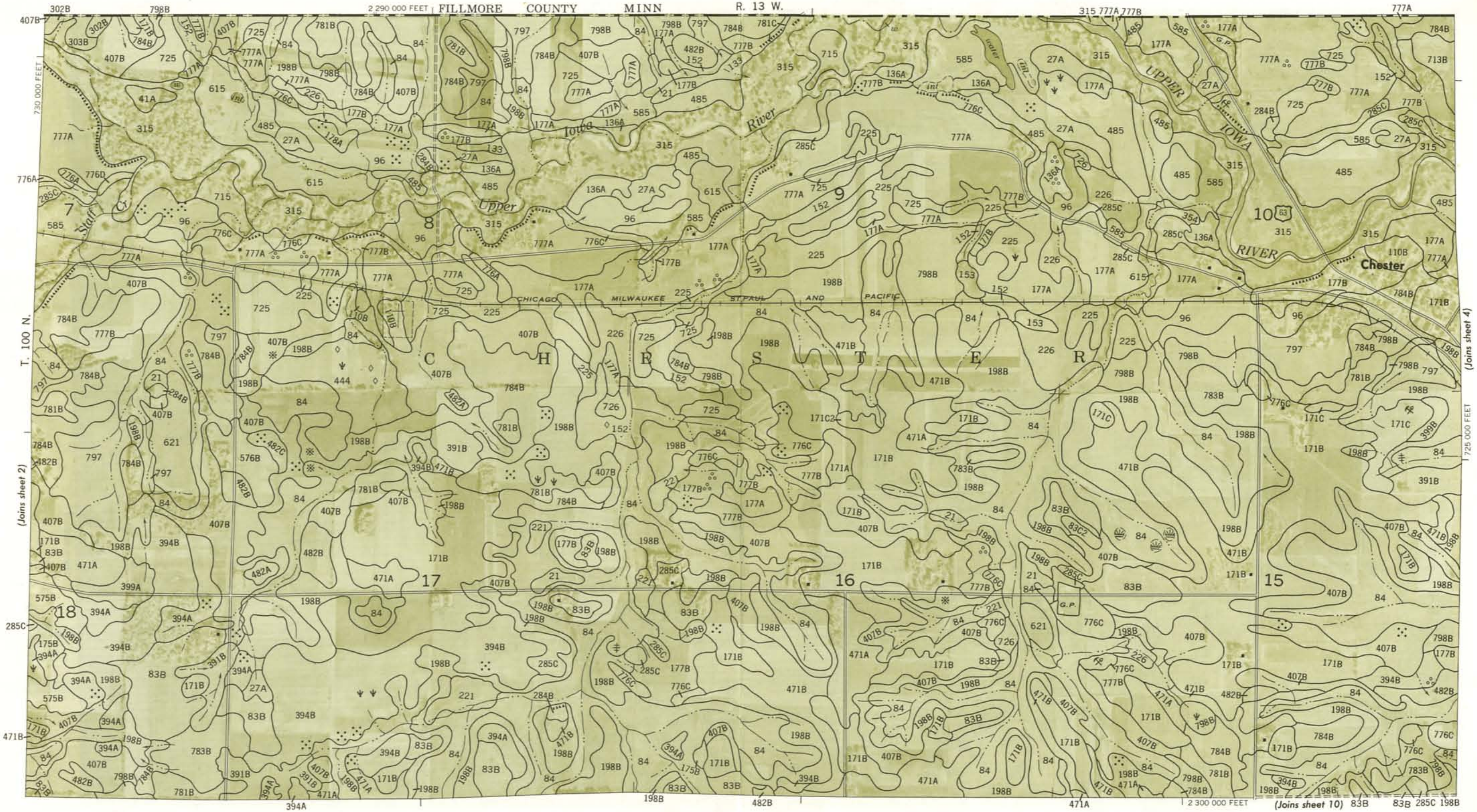
N


2 250 000 FEET
MOWER COUNTY MINNESOTA
R. 14 W.
730 000 FEET
T. 100 N.
MITCHELL COUNTY
CHICAGO AND NORTH WESTERN
O A K D A L E
7
8
9
16
17
18
Staff Creek
(Joins sheet 2)
(Joins sheet 8)
720 000 FEET
2 265 000 FEET

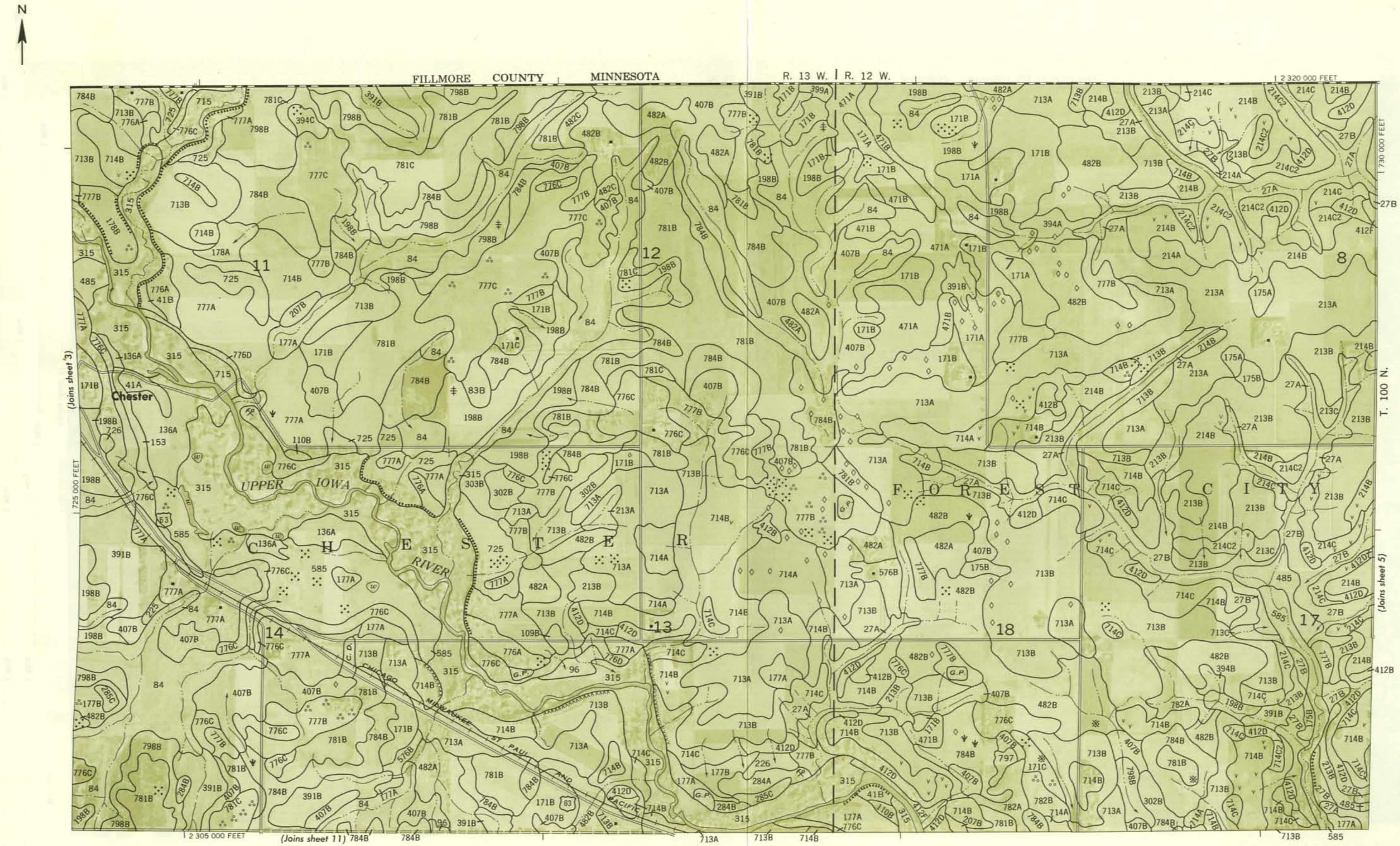
2


N
R. 14 W.
R. 13 W.
MOWER CO MINN
FILLMORE COUNTY MINN
2 285 000 FEET
730 000 FEET
720 000 FEET
2 270 000 FEET
T. 100 N.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 9)
OAKDALE
STERN
Upper Iowa River
Staff Creek
QUARRY
GRAVEL PIT
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
G.P.

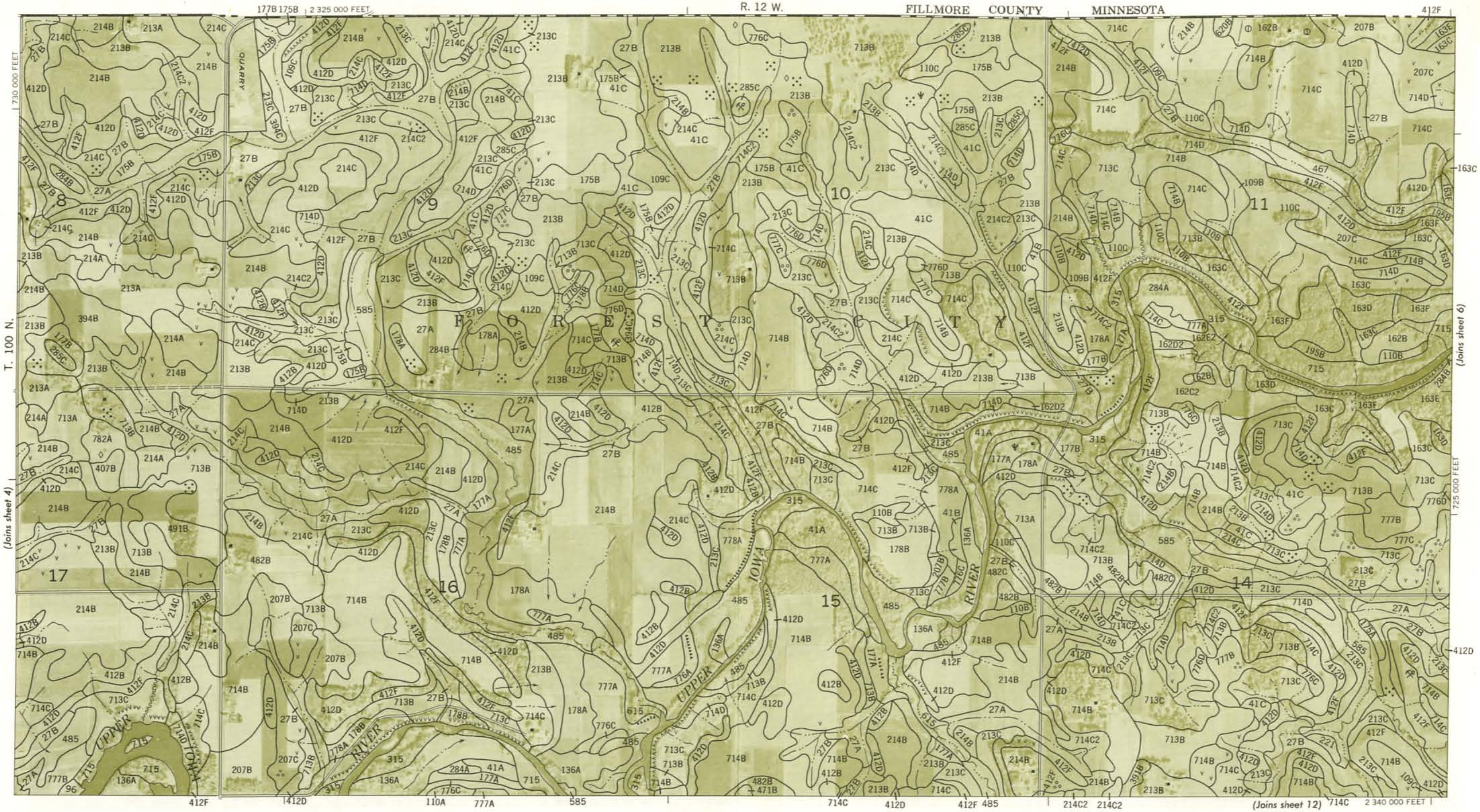
N


2 290 000 FEET
FILLMORE COUNTY MINN
R. 13 W.
730 000 FEET
T. 100 N.
(Joins sheet 2)
(Joins sheet 4)
725 000 FEET
2 300 000 FEET
(Joins sheet 10)
Upper Iowa River
UPPER IOWA RIVER
Staff Cr
Chester
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
C H E S T E R
7
8
9
10
15
16
17
18
G.P.

HOWARD COUNTY, IOWA — SHEET NUMBER 4

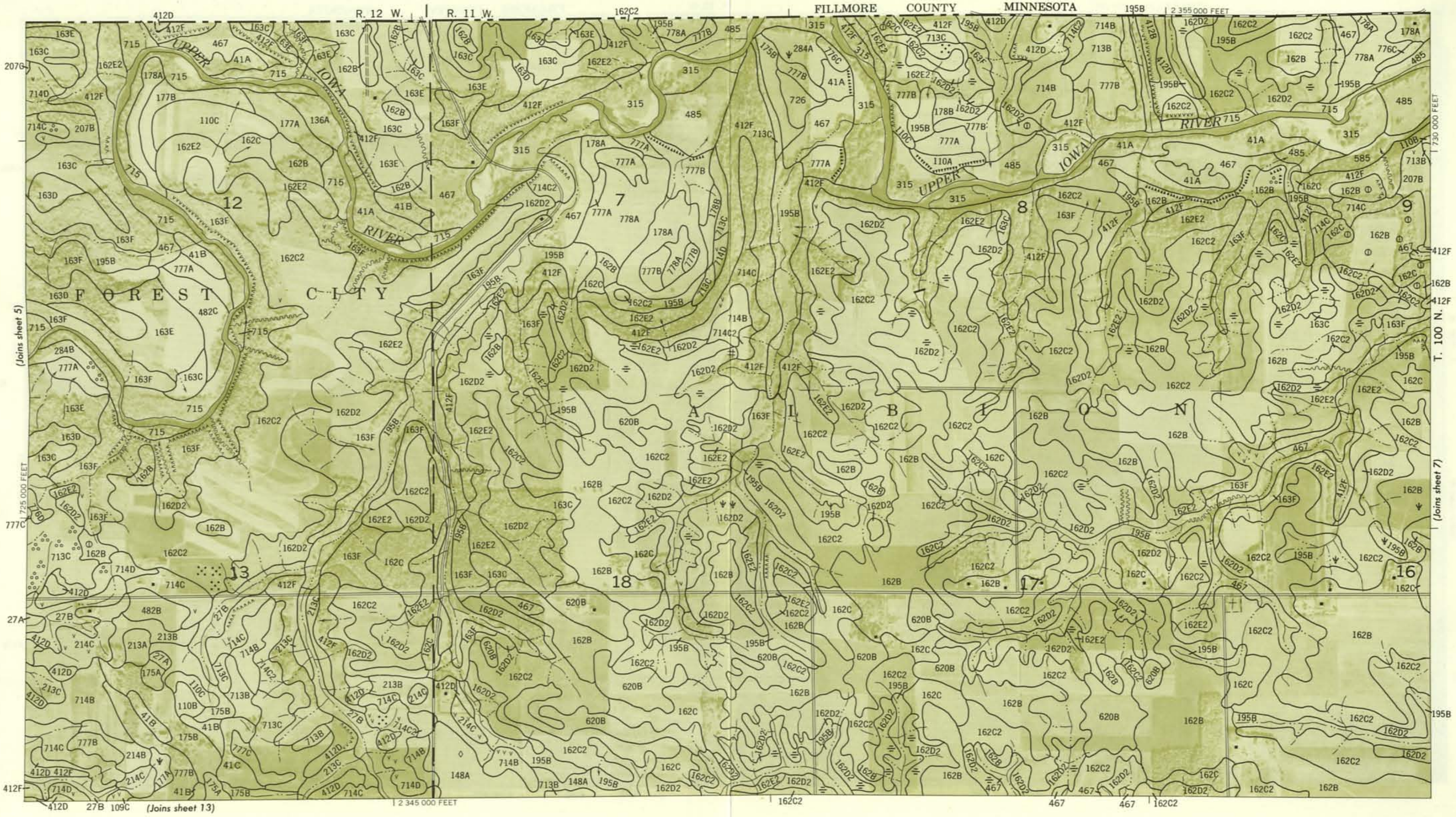


N


R. 12 W.
FILLMORE COUNTY
MINNESOTA
2 325 000 FEET
730 000 FEET
725 000 FEET
2 340 000 FEET
T. 100 N.
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 12)
QUARRY
FOREST CITY
UPPER IOWA RIVER
8
9
10
11
14
15
16
17

HOWARD COUNTY, IOWA — SHEET NUMBER 6

N

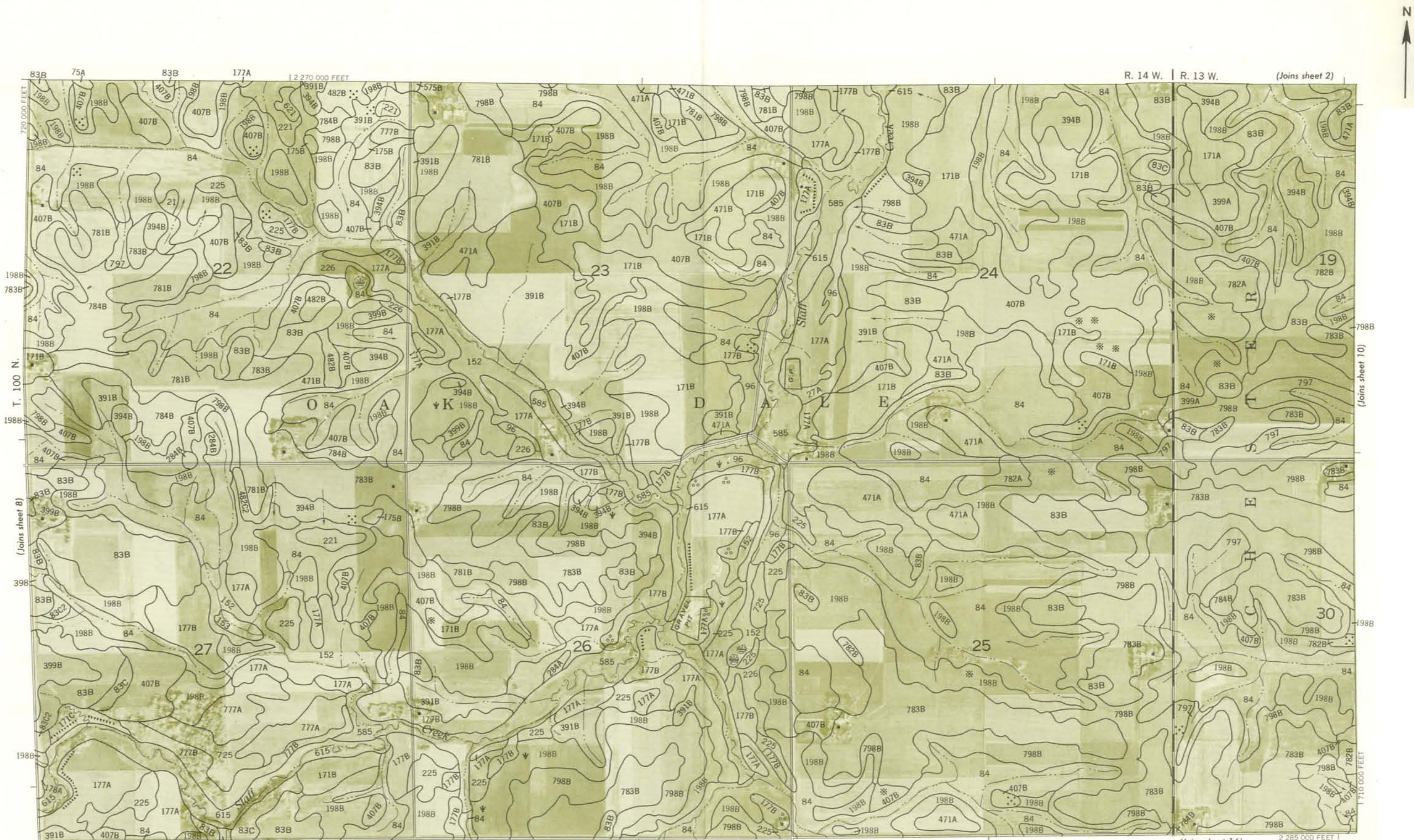


N

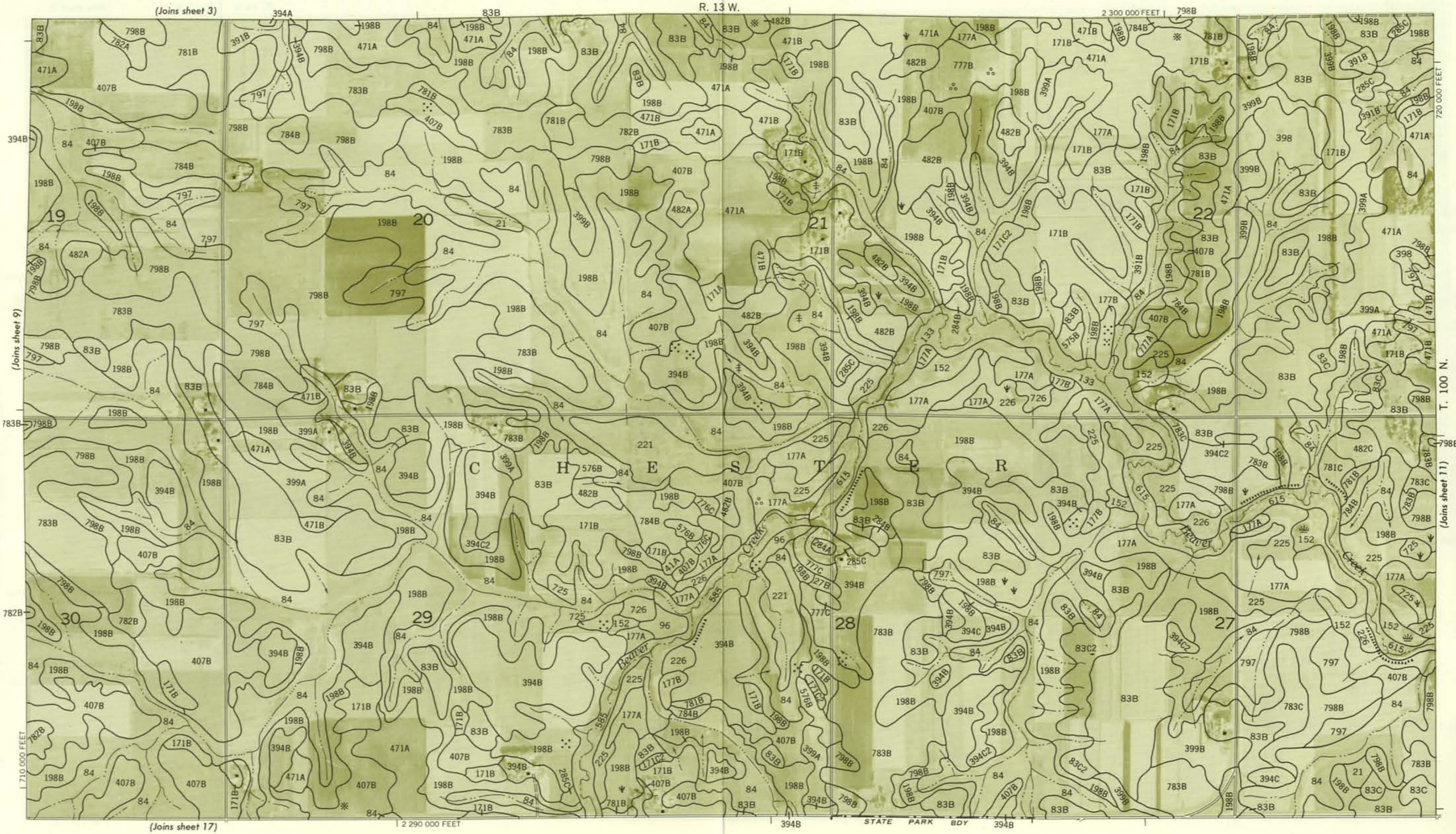

R. 11 W.
FILLMORE COUNTY
MINNESOTA
WINNESHIEK COUNTY
T. 100 N.
2 360 000 FEET
2 375 000 FEET
730 000 FEET
725 000 FEET
(Joins sheet 6)
(Joins sheet 14)
Florenceville
UPPER IOWA RIVER
Nichols Creek
A L B I O N
9
10
11
12
13
14
15
16

N

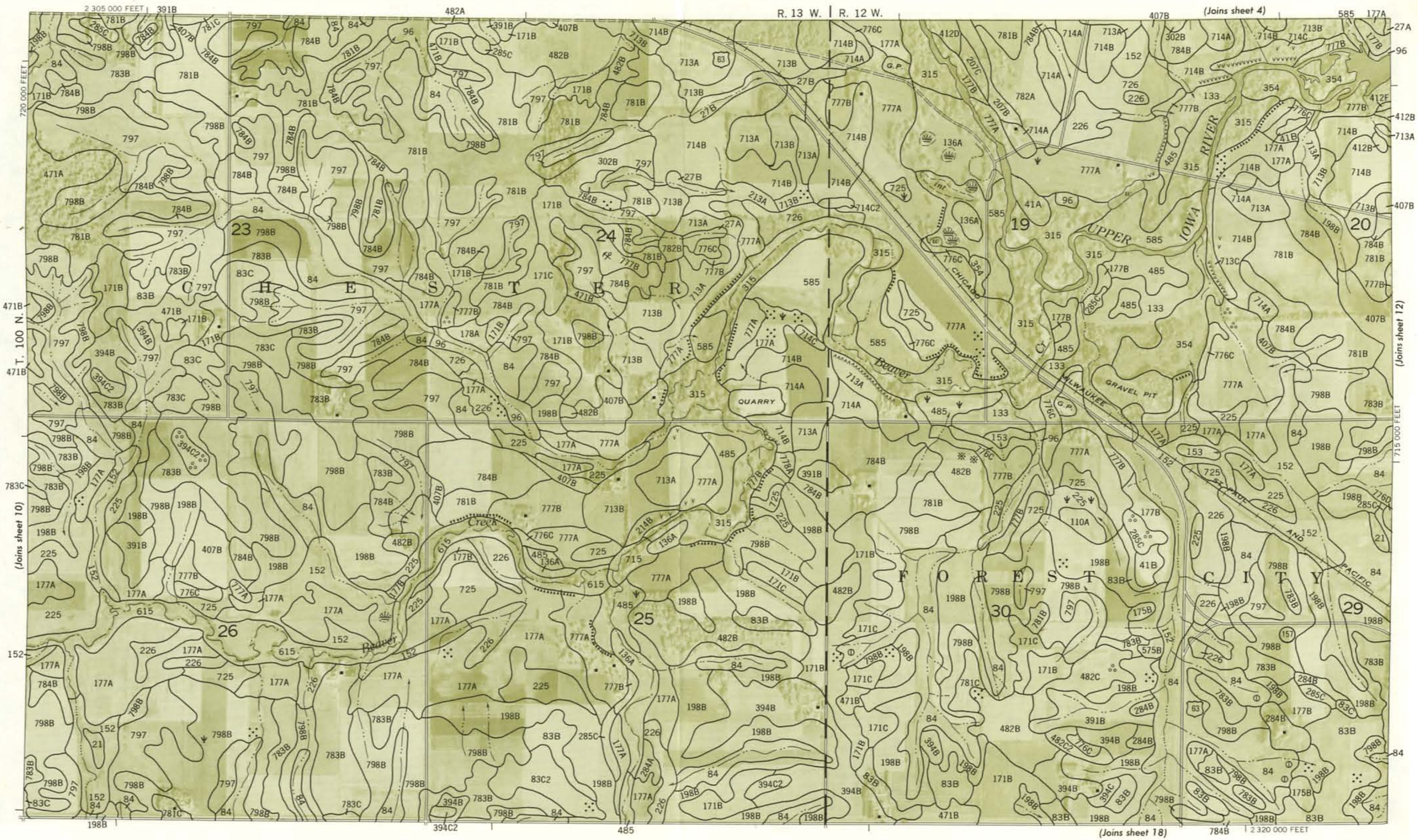

R. 14 W.
(Joins sheet 1)
2 265 000 FEET
720 000 FEET
T. 100 N.
(Joins sheet 9)
(Joins sheet 15)
2 250 000 FEET
710 000 FEET
MITCHELL COUNTY
O A K D A L E
19
20
21
28
29
30
Staff Creek
Staff Creek


N
R. 14 W.
R. 13 W.
(Joins sheet 2)
(Joins sheet 10)
(Joins sheet 8)
(Joins sheet 16)
T. 100 N.
2 270 000 FEET
2 285 000 FEET
720 000 FEET
710 000 FEET
22
23
24
19
27
26
25
30
O A K D A L E
GRAVEL PIT
Creek

N

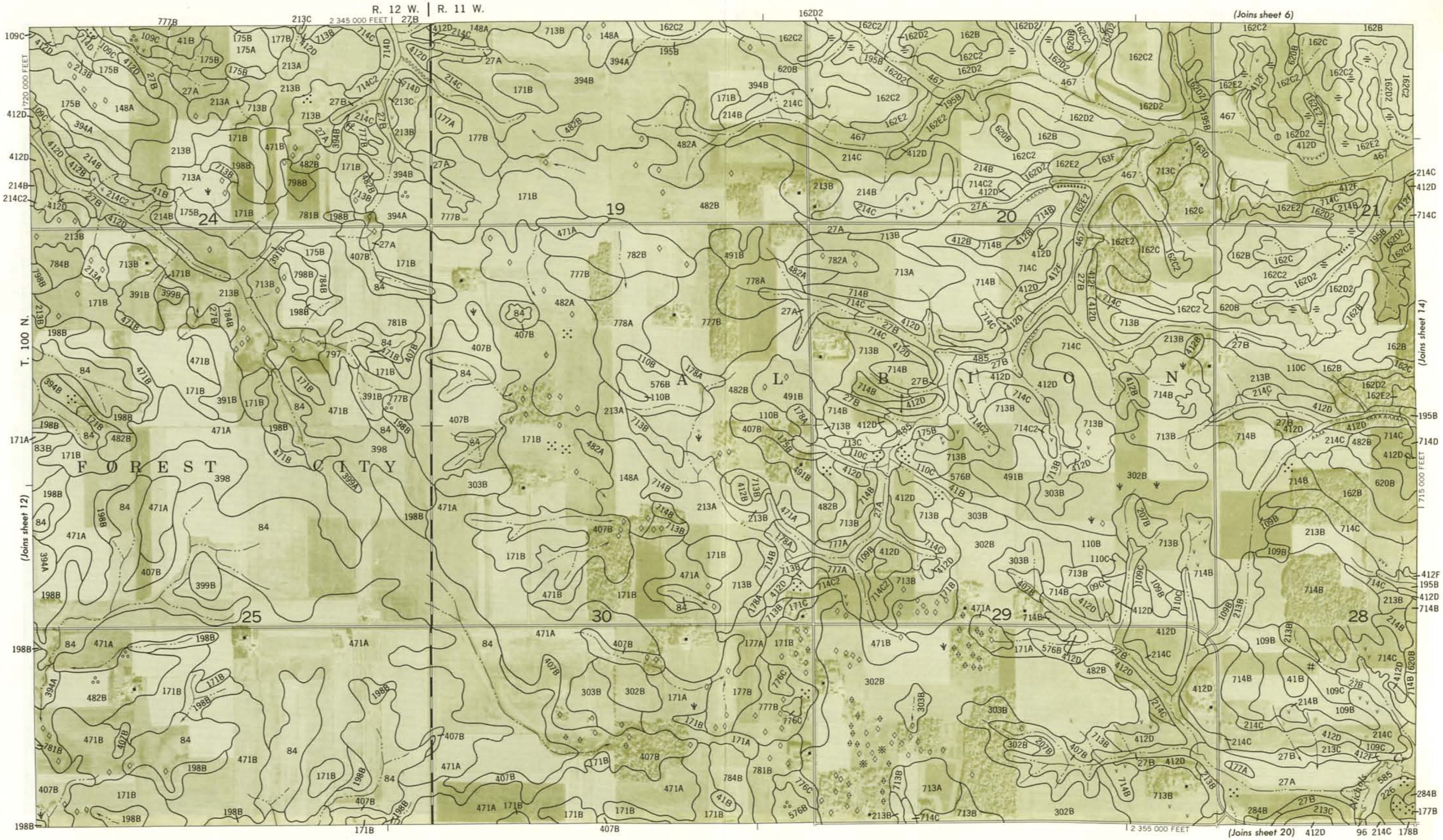

(Joins sheet 3)
R. 13 W.
2 300 000 FEET
720 000 FEET
T. 100 N.
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 17)
2 290 000 FEET
710 000 FEET
STATE PARK BDY
C H E S T E R
Beaver Creek
19
20
21
22
27
28
29
30

11


N
R. 13 W.
R. 12 W.
T. 100 N.
(Joins sheet 4)
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 18)
2 305 000 FEET
2 320 000 FEET
720 000 FEET
715 000 FEET
C H E S T E R
F O R E S T C I T Y
UPPER IOWA RIVER
Beaver Creek
Beaver
Beaver Cr.
QUARRY
GRAVEL PIT
G.P.
CHICAGO MILWAUKEE ST. PAUL AND PACIFIC
19
20
23
24
25
26
29
30

N


(Joins sheet 5)
R. 12 W.
2 340 000 FEET
720 000 FEET
715 000 FEET
T. 100 N.
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 19)
2 325 000 FEET
UPPER IOWA RIVER
FOREST CITY
Lime Springs
C. M. ST. P. AND P.
C.D.
G.P.
20
21
22
23
26
27
28
29


N
R. 12 W.
R. 11 W.
2 345 000 FEET
2 355 000 FEET
720 000 FEET
715 000 FEET
T. 100 N.
(Joins sheet 6)
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 20)
F O R E S T   C I T Y
A L B I O N
19
20
21
24
25
28
29
30

N

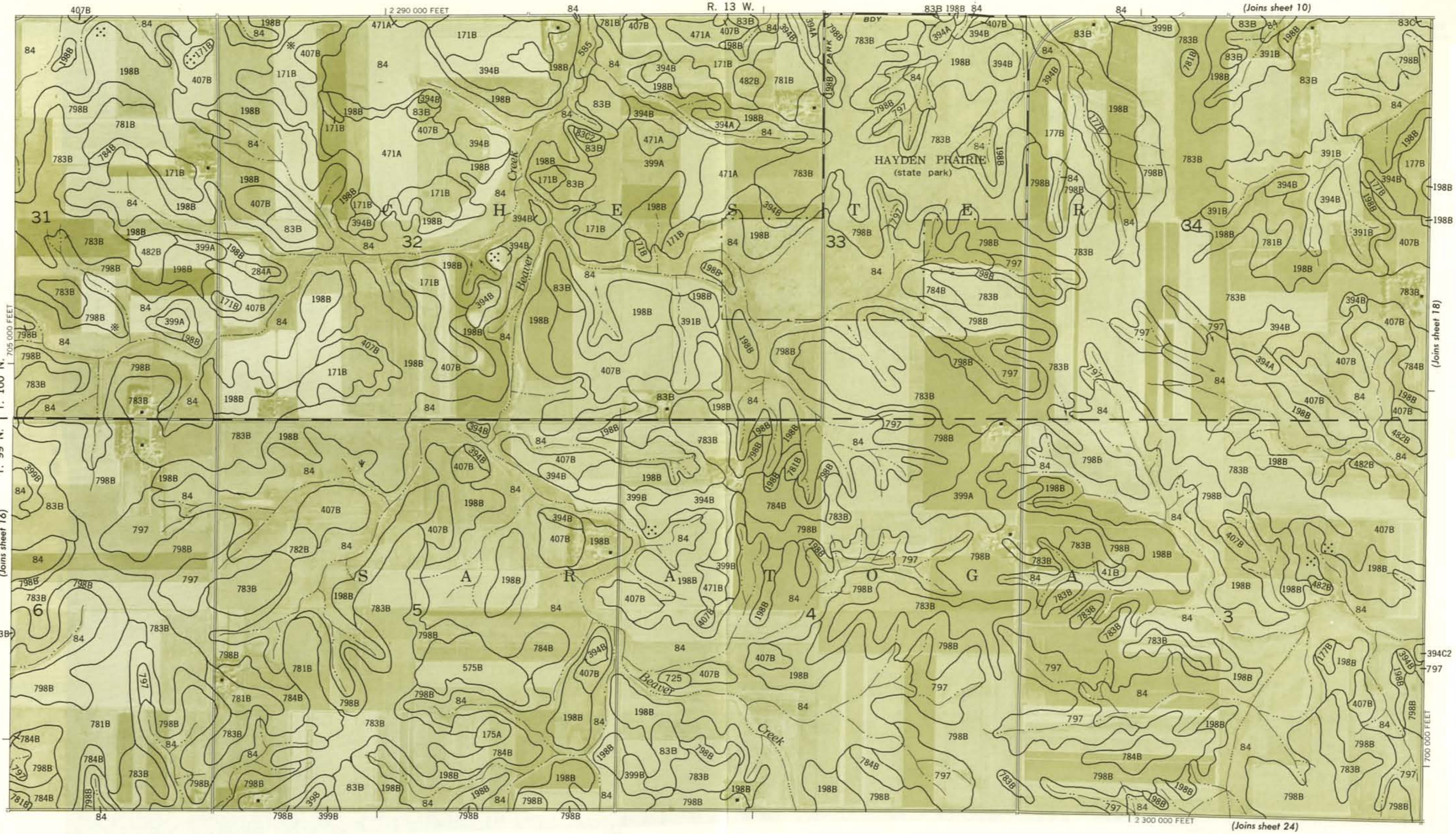

(Joins sheet 7)
R. 11 W.
2 375 000 FEET
720 000 FEET
T. 100 N.
WINNESHIEK COUNTY
(Joins sheet 13)
715 000 FEET
2 360 000 FEET
(Joins sheet 21)
Nichols Creek
A L B I O N
21
22
23
24
25
26
27
28

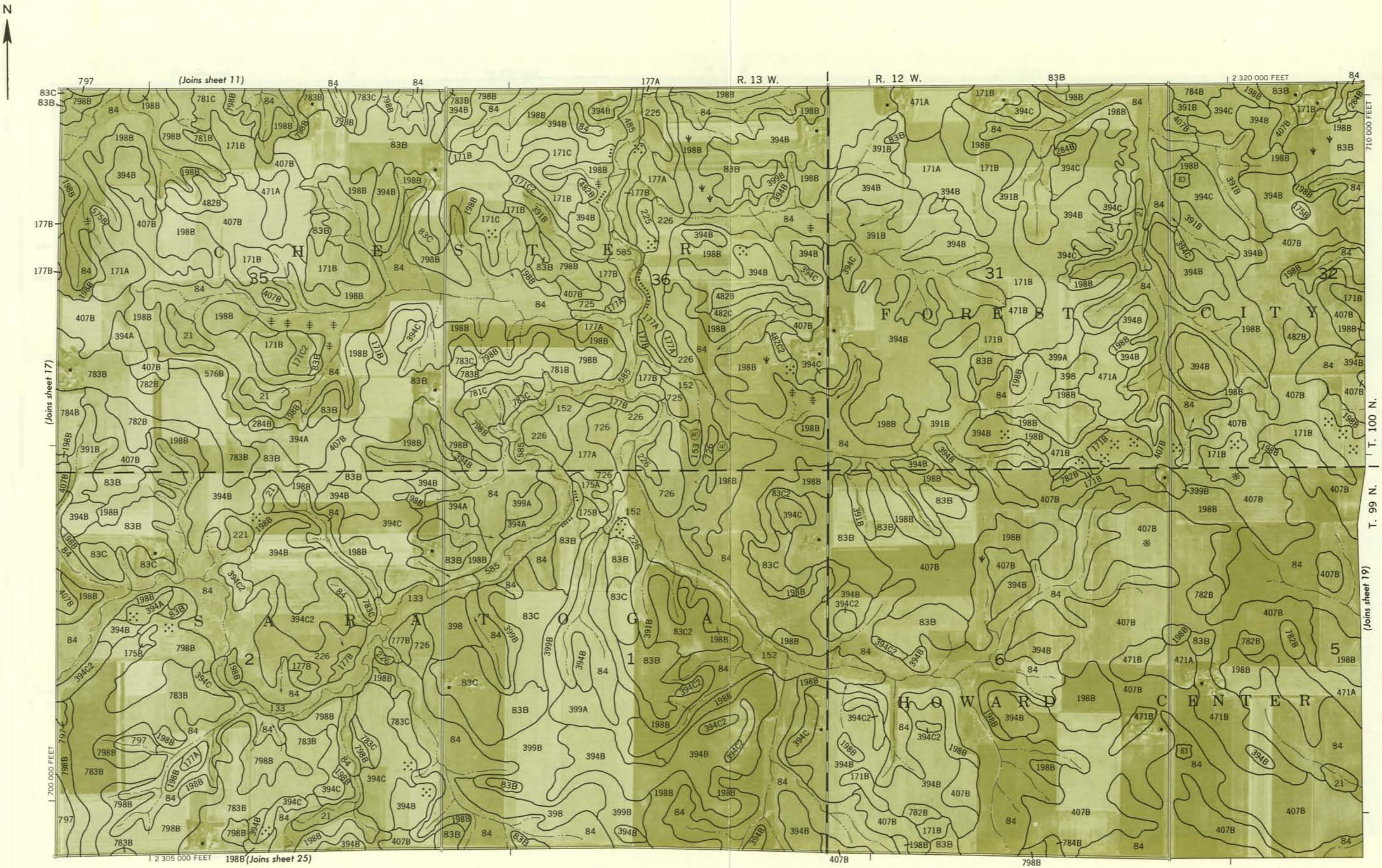

N
(Joins sheet 8)
(Joins sheet 16)
(Joins sheet 22)
R. 14 W.
T. 100 N.
T. 99 N.
MITCHELL COUNTY
2 250 000 FEET
2 265 000 FEET
705 000 FEET
700 000 FEET
31
32
33
6
5
4
O A K D A L E
J A M E S T O W N

N


(Joins sheet 9)
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 23)
R. 14 W.
R. 13 W.
T. 100 N.
T. 99 N.
2 285 000 FEET
2 270 000 FEET
705 000 FEET
700 000 FEET
OAKDALE
JAMESTOWN
CHESTER
SARATOGA
34
35
36
31
3
2
1
6
Crane Creek

N

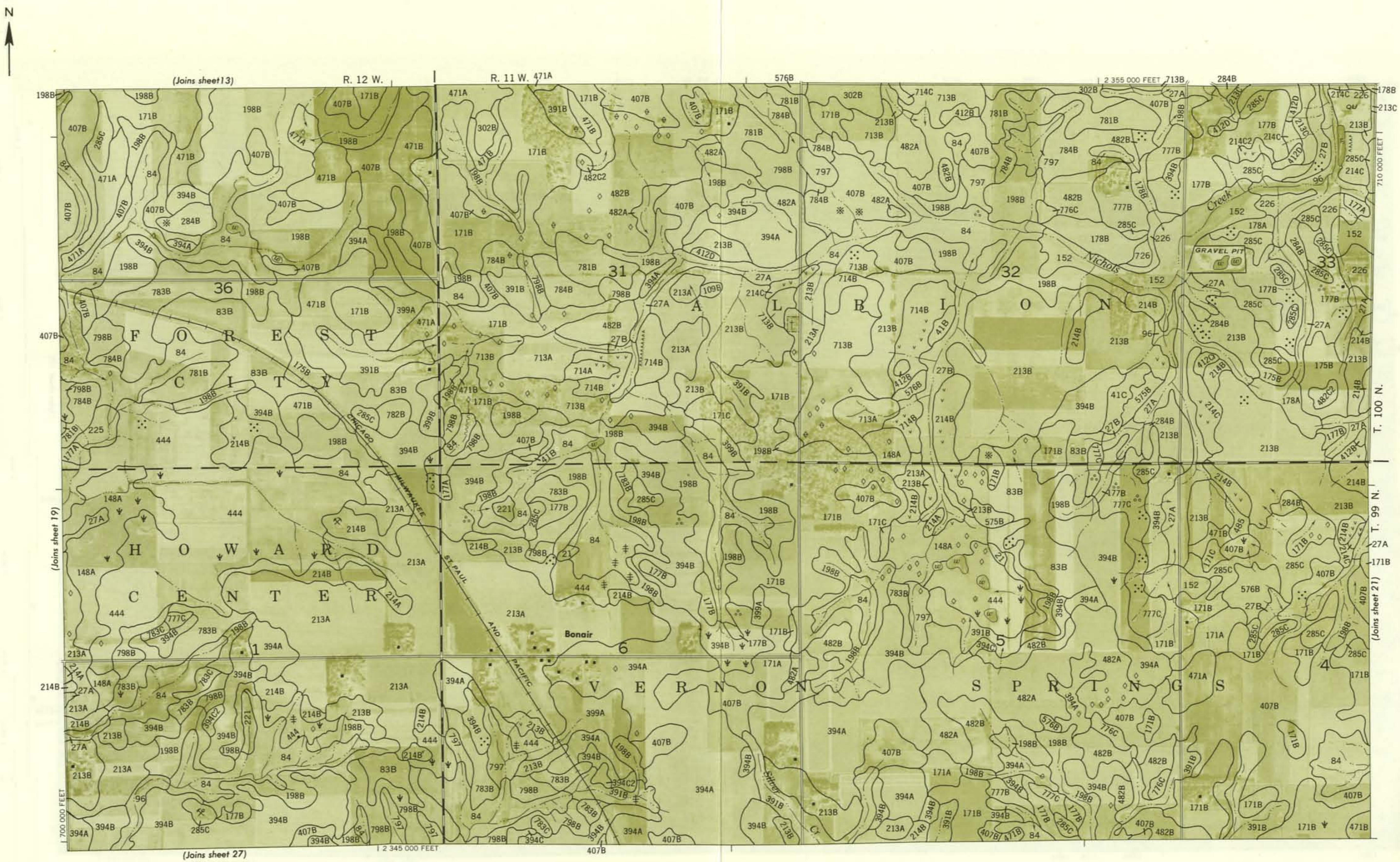

R. 13 W.
2 290 000 FEET
(Joins sheet 10)
(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 16)
2 300 000 FEET
705 000 FEET
700 000 FEET
T. 100 N.
T. 99 N.
HAYDEN PRAIRIE
(state park)
PARK
BDY
Beaver
Creek
C H E S T E R
S A R A T O G A
31
32
33
34
6
5
4
3

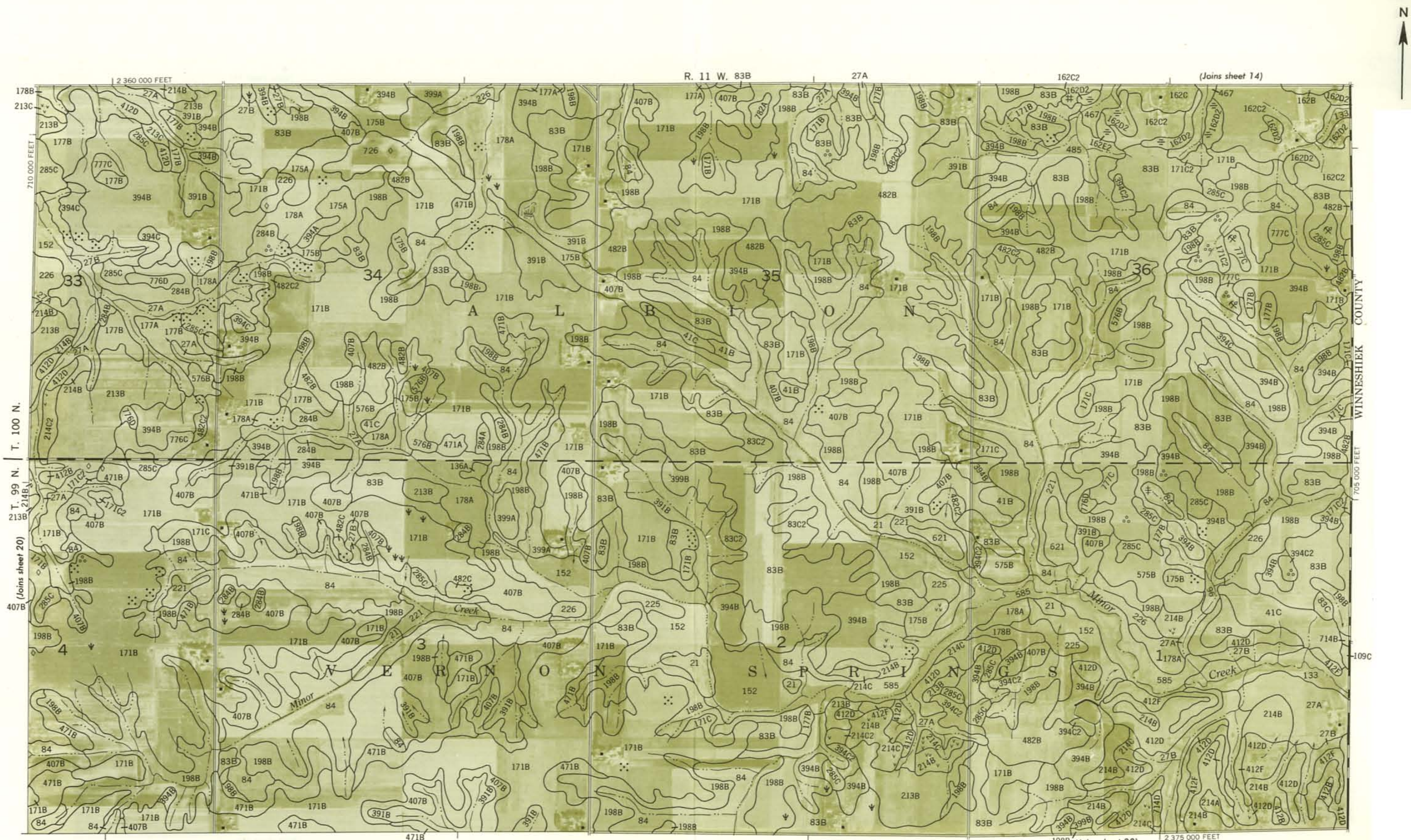

N
(Joins sheet 11)
R. 13 W.
R. 12 W.
2 320 000 FEET
710 000 FEET
(Joins sheet 17)
(Joins sheet 19)
T. 100 N.
T. 99 N.
C H E S T E R
F O R E S T C I T Y
S A R A T O G A
H O W A R D C E N T E R
35
36
31
32
2
1
6
5
700 000 FEET
2 305 000 FEET
(Joins sheet 25)

N


R. 12 W.
T. 100 N.
T. 99 N.
(Joins sheet 12)
(Joins sheet 20)
(Joins sheet 26)
(Joins sheet 18)
2 325 000 FEET
2 340 000 FEET
710 000 FEET
700 000 FEET
F O R E S T C I T Y
H O W A R D C E N T E R
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
North Branch Turkey River
32
33
34
35
5
4
3
2

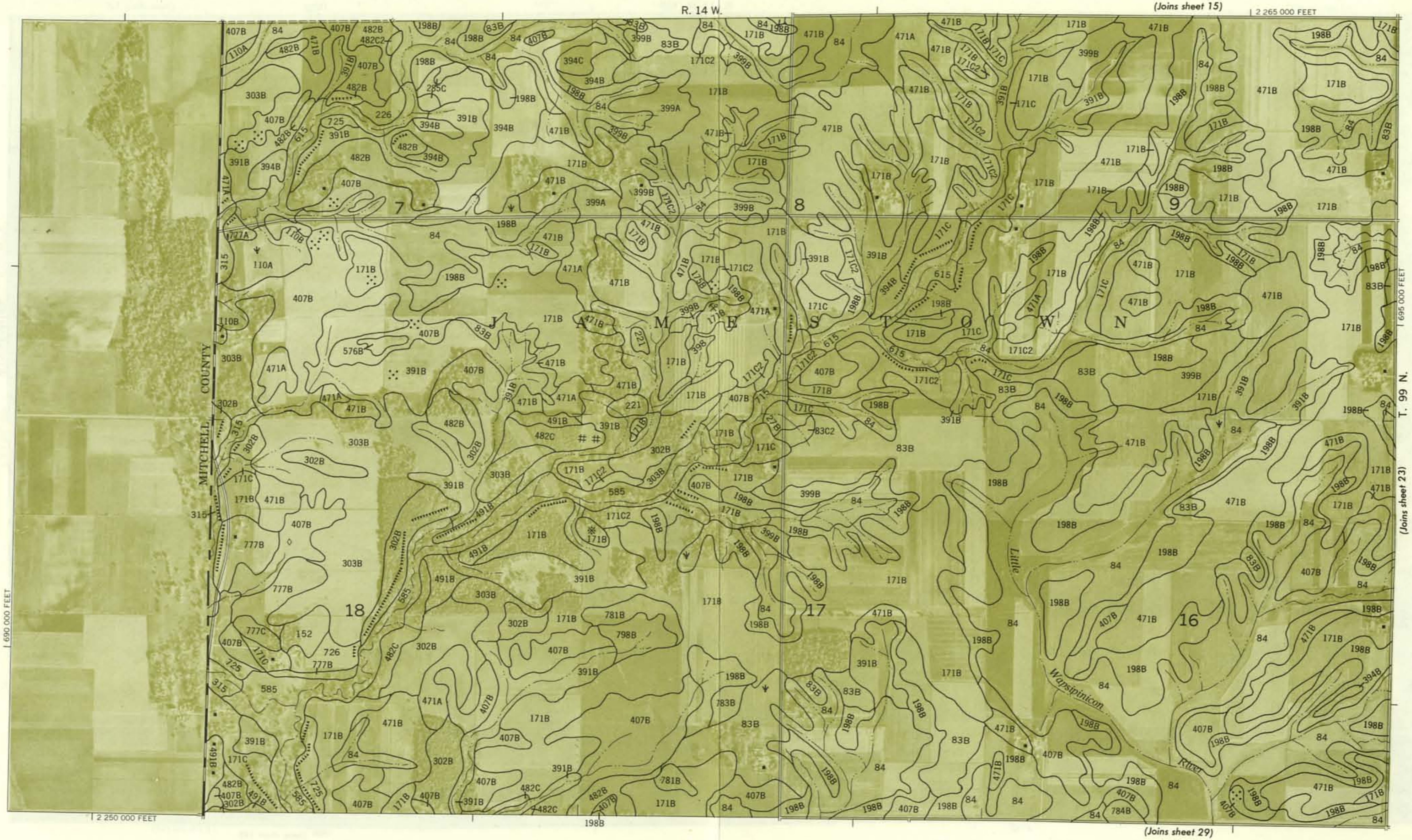
HOWARD COUNTY, IOWA — SHEET NUMBER 20

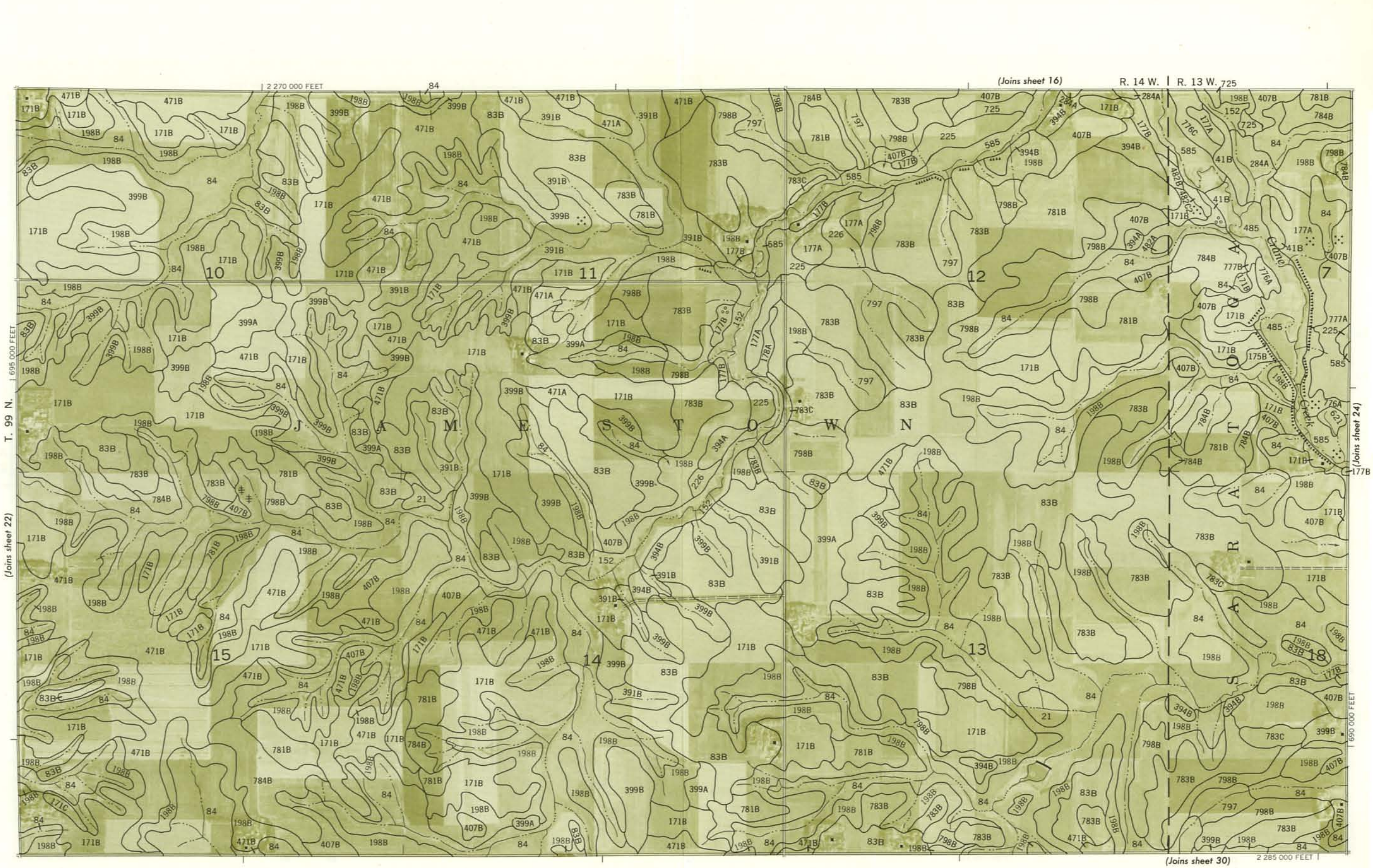



N
2 360 000 FEET
R. 11 W.
(Joins sheet 14)
710 000 FEET
T. 100 N.
T. 99 N.
(Joins sheet 20)
WINNESHIEK COUNTY
705 000 FEET
(Joins sheet 28)
2 375 000 FEET
A L B I O N
V E R N O N S P R I N G S
33
34
35
36
4
3
2
1
Minor Creek
Minor Creek

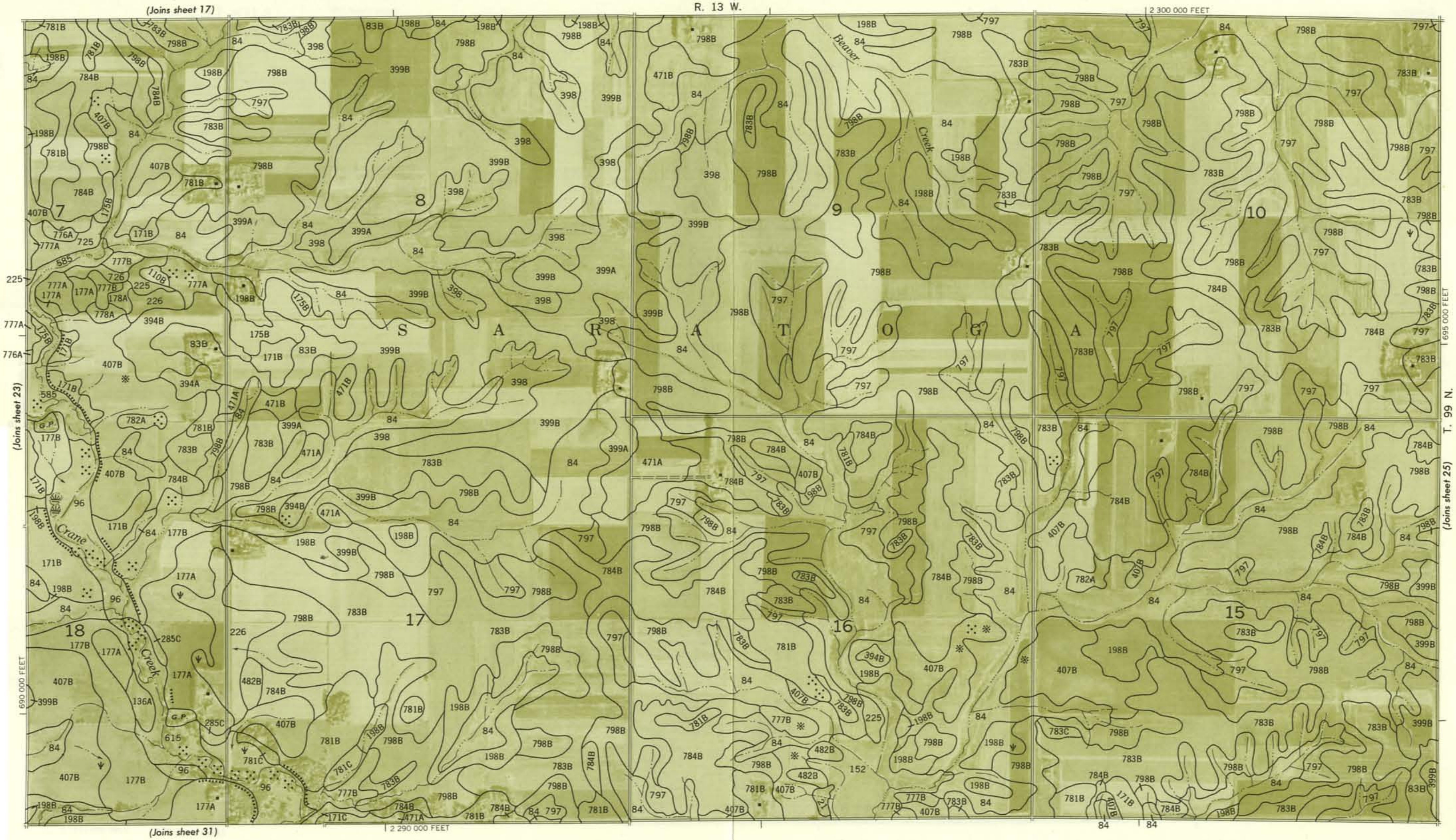
N

HOWARD COUNTY, IOWA — SHEET NUMBER 22

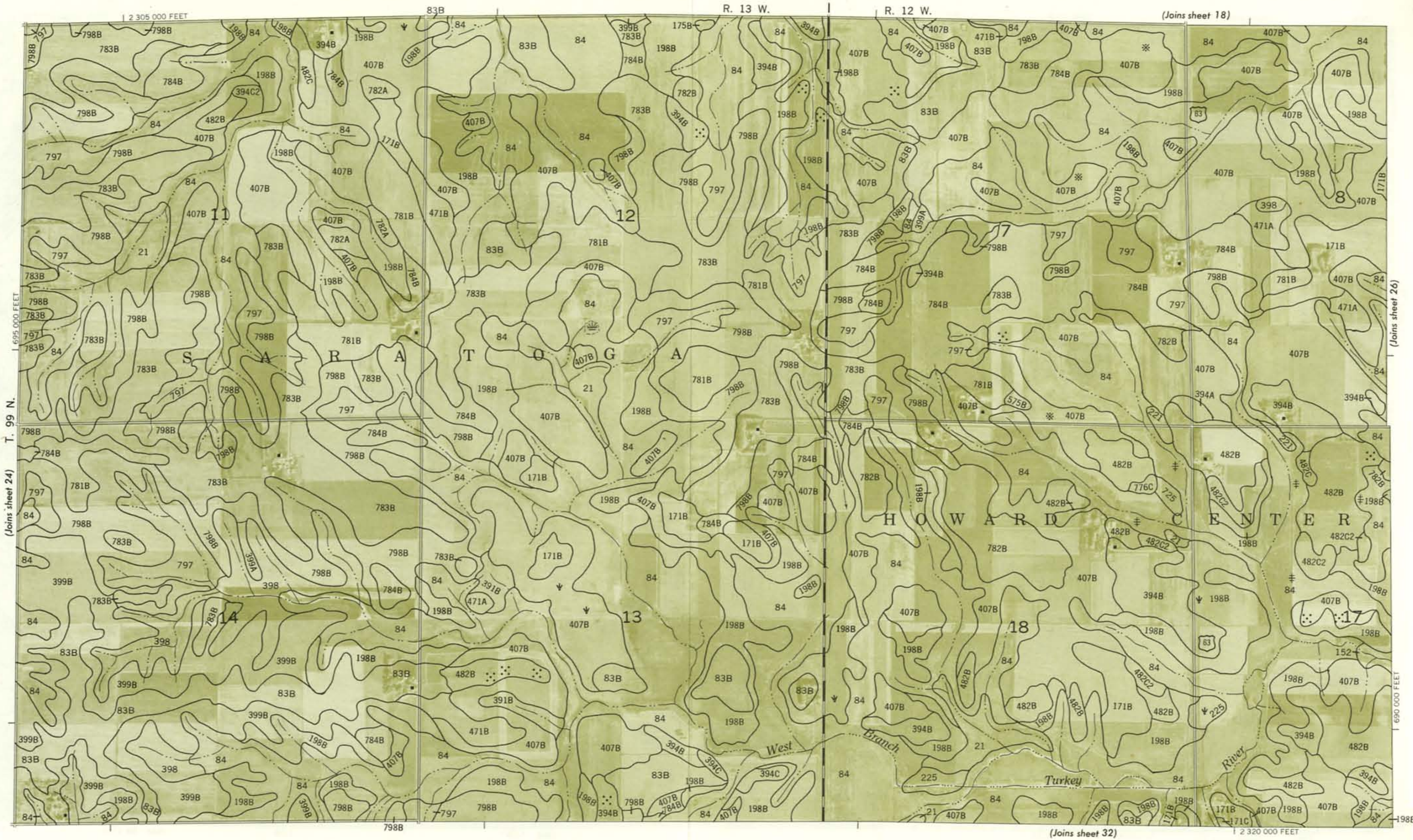


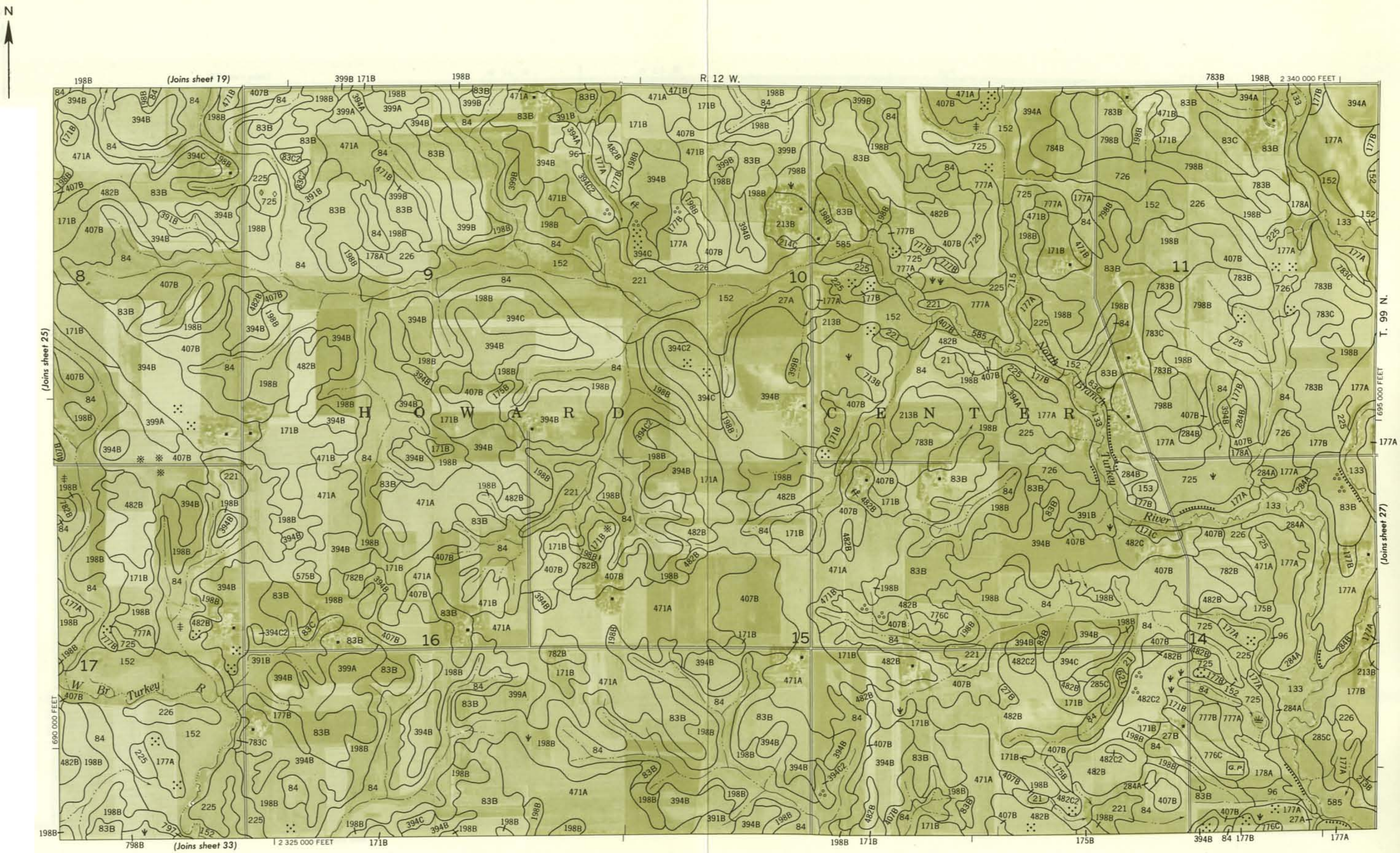

N
(Joins sheet 16)
R. 14 W.
R. 13 W.
2 270 000 FEET
T. 99 N.
695 000 FEET
(Joins sheet 22)
(Joins sheet 24)
690 000 FEET
(Joins sheet 30)
2 285 000 FEET
J A M E S T O W N
S A R A T O G A
Crane Creek
10
11
12
7
15
14
13
18

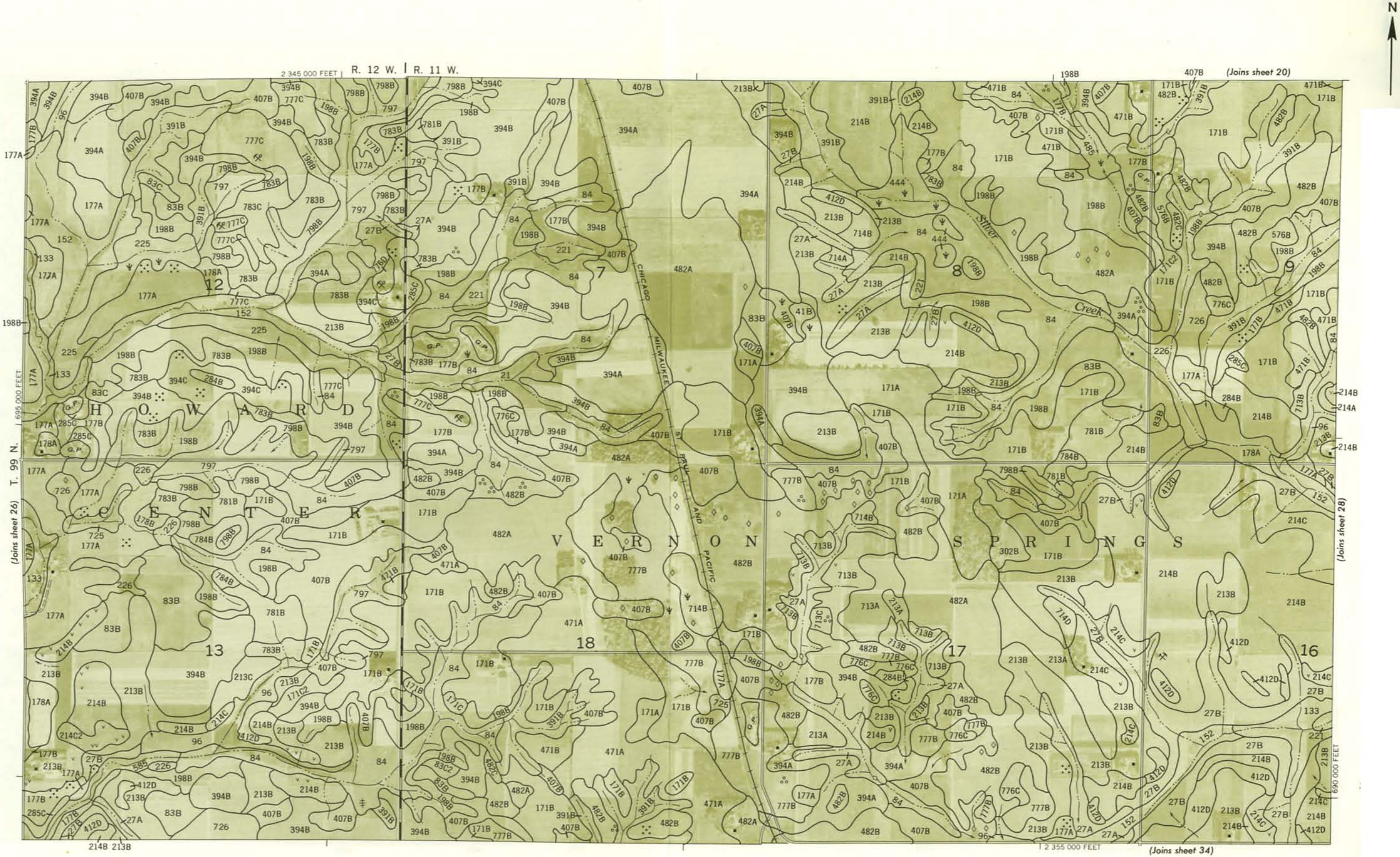
N


(Joins sheet 17)
R. 13 W.
2 300 000 FEET
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 31)
T. 99 N.
695 000 FEET
690 000 FEET
2 290 000 FEET
S A R A T O G A
Beaver Creek
Crane Creek
7
8
9
10
15
16
17
18

N


R. 13 W.
R. 12 W.
(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 32)
2 305 000 FEET
2 320 000 FEET
695 000 FEET
690 000 FEET
T. 99 N.
S A R A T O G A
H O W A R D C E N T E R
11
12
7
8
14
13
18
17
West Branch Turkey River
83
225
221
152

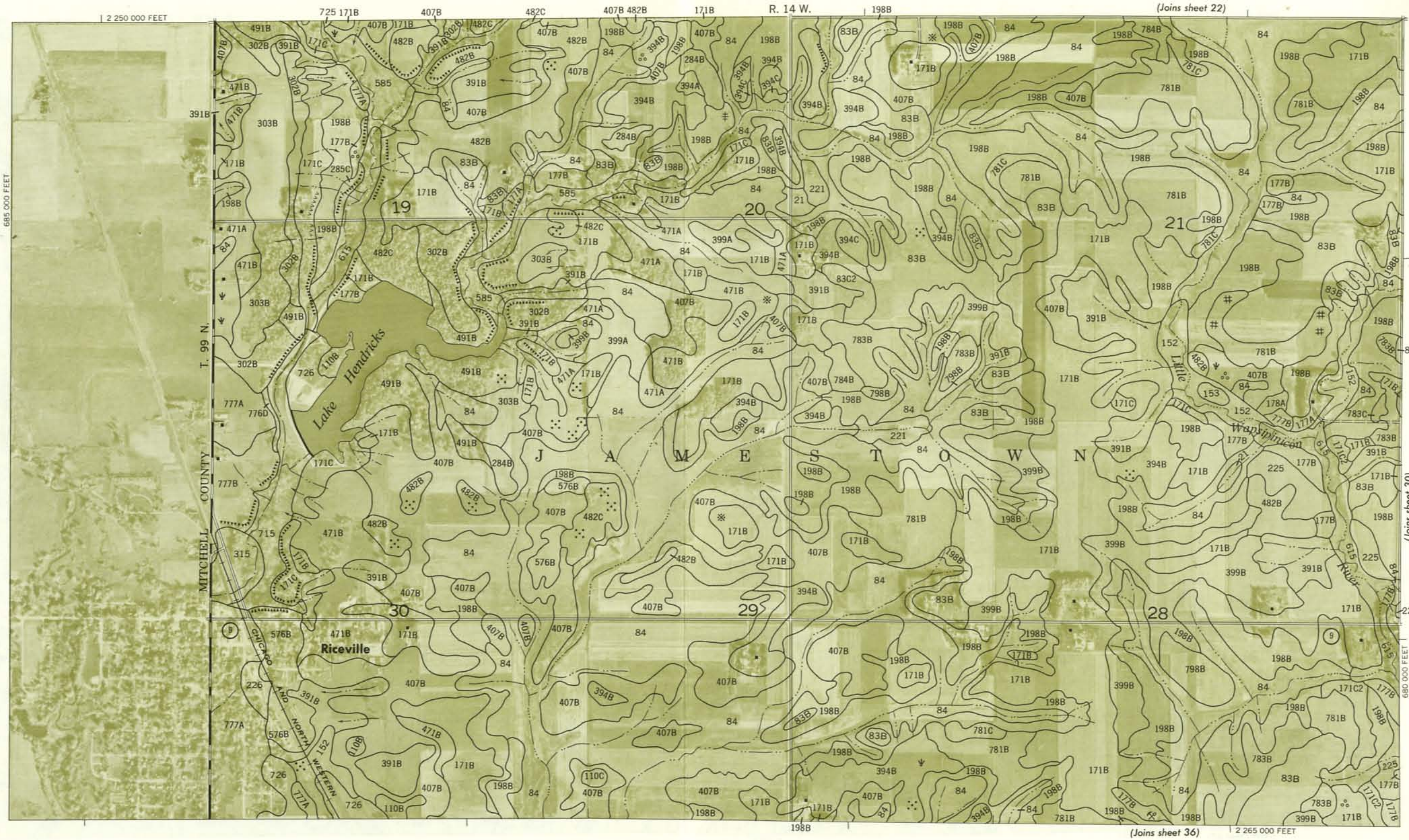

N
(Joins sheet 19)
R. 12 W.
2 340 000 FEET
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 33)
T. 99 N.
695 000 FEET
690 000 FEET
2 325 000 FEET
HOWARD CENTER
8
9
10
11
14
15
16
17
North Branch Turkey River
W. Br. Turkey R.
G.P.


N
R. 12 W.
R. 11 W.
T. 99 N.
2 345 000 FEET
2 355 000 FEET
696 000 FEET
690 000 FEET
(Joins sheet 20)
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 34)
H O W A R D
C E N T E R
V E R N O N
S P R I N G S
CHICAGO
MILWAUKEE
ST PAUL
AND
PACIFIC
Silver
Creek
12
7
8
9
13
18
17
16

N


(Joins sheet 21)
R. 11 W.
2 375 000 FEET
700 000 FEET
T. 99 N.
WINNESHIEK COUNTY
(Joins sheet 27)
690 000 FEET
2 360 000 FEET
(Joins sheet 35)
VERNON SPRINGS
Silver Creek
Creek
QUARRY
9
10
11
12
13
14
15
16

N



(Joins sheet 22)
(Joins sheet 30)
(Joins sheet 36)
2 250 000 FEET
2 265 000 FEET
685 000 FEET
680 000 FEET
R. 14 W.
T. 99 N.
MITCHELL COUNTY
J A M E S T O W N
Lake Hendricks
Riceville
Little Wapsipinicon River
CHICAGO AND NORTH WESTERN
19
20
21
28
29
30

N


(Joins sheet 23)
R. 14 W.
R. 13 W.
2 285 000 FEET
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 37)
685 000 FEET
680 000 FEET
2 270 000 FEET
T. 99 N.
J A M E S T O W N
S A R A T O G A
22
23
24
19
27
26
25
30
Wapsipinicon R.

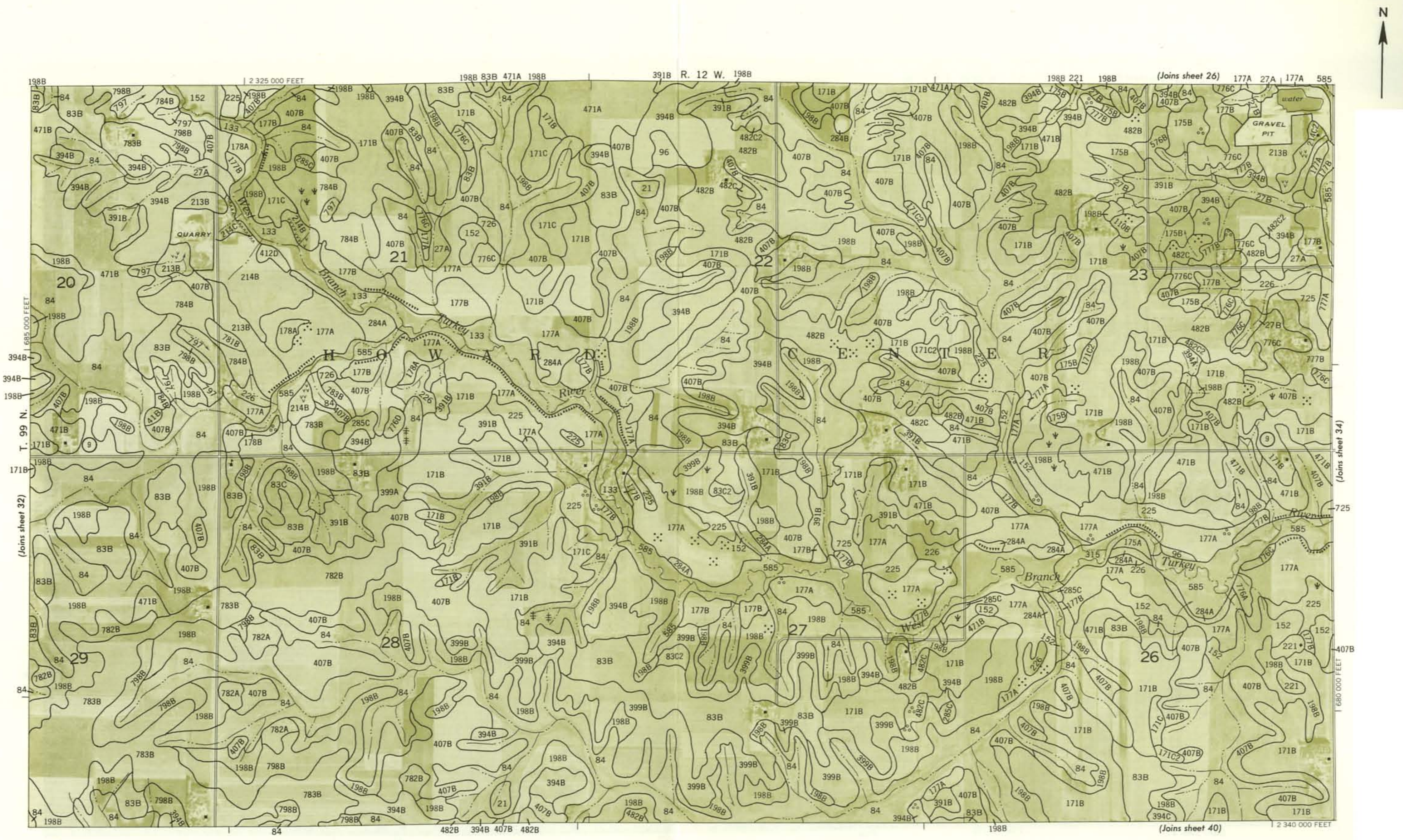
31

N


R. 13 W.
(Joins sheet 24)
(Joins sheet 32)
(Joins sheet 38)
(Joins sheet 30)
T. 99 N.
2 290 000 FEET
2 300 000 FEET
685 000 FEET
680 000 FEET
S A R A T O G A
Saratoga
CRANE
CREEK
G.P.
19
20
21
22
27
28
29
30

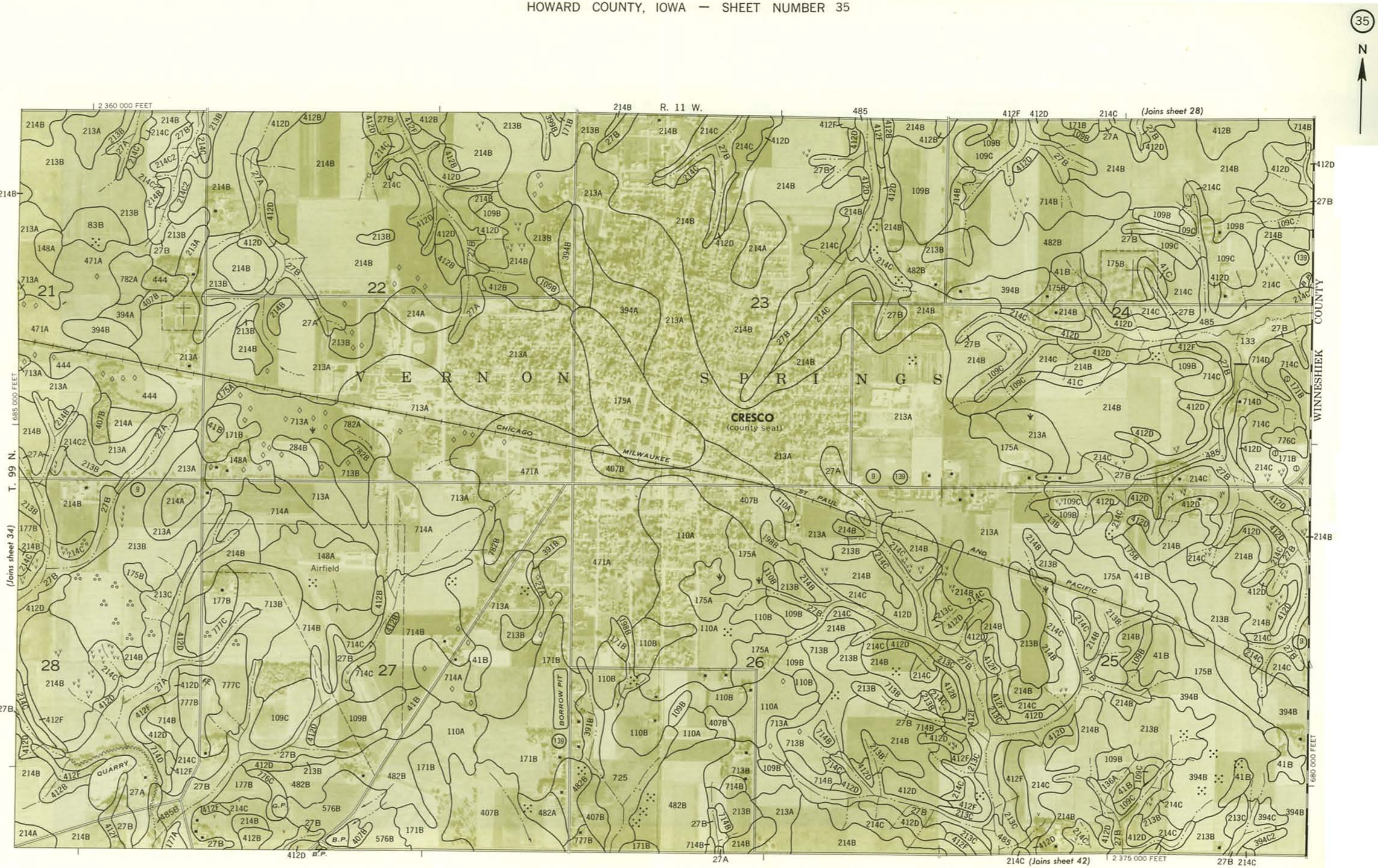
N


(Joins sheet 25)
R. 13 W.
R. 12 W.
2 320 000 FEET
685 000 FEET
T. 99 N.
(Joins sheet 31)
(Joins sheet 33)
680 000 FEET
2 305 000 FEET
(Joins sheet 39)
S A R A T O G A
H O W A R D C E N T E R
Davis Corners
Turkey
River
23
24
19
20
26
25
30
29

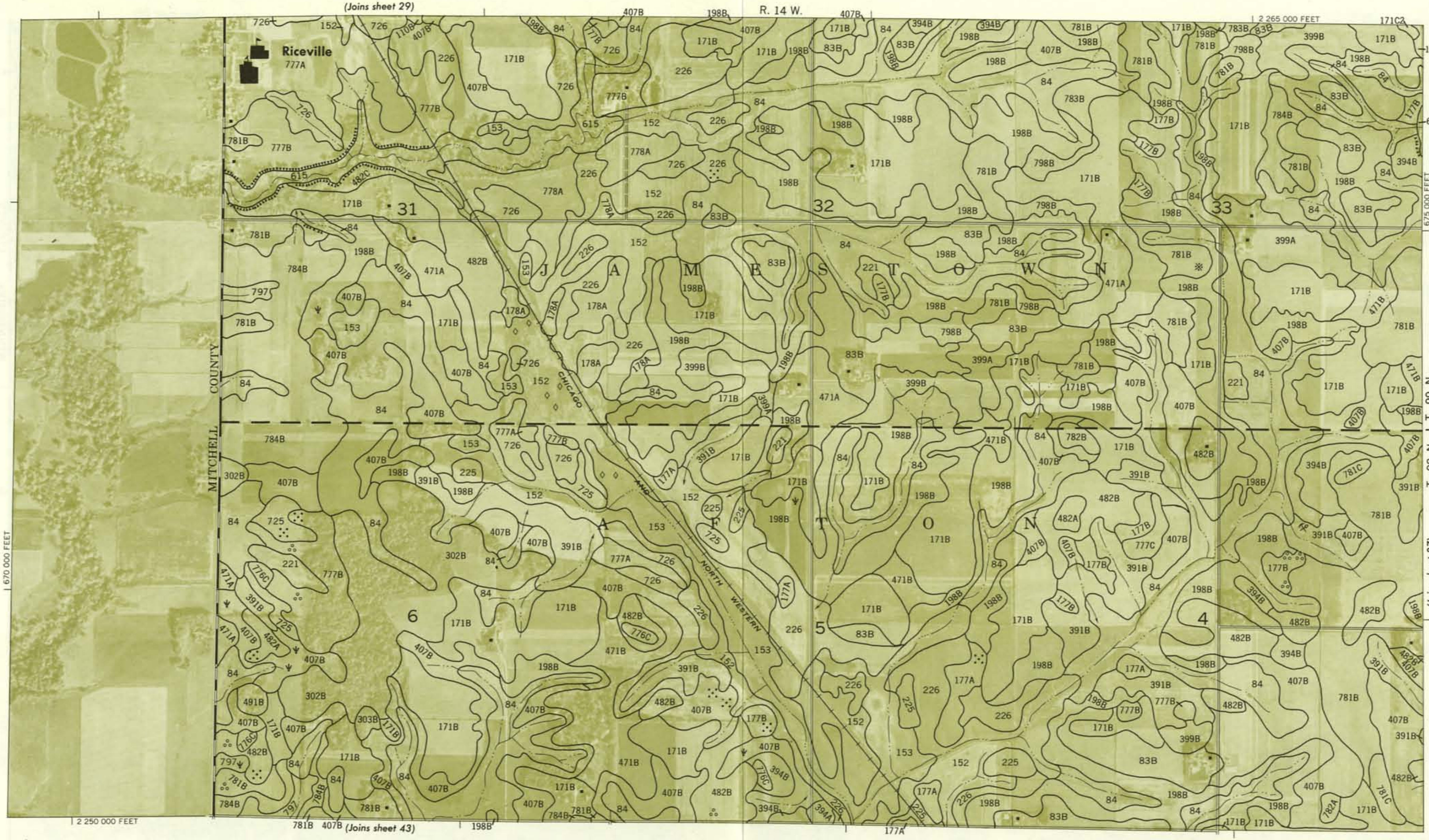

N
R. 12 W.
T. 99 N.
(Joins sheet 26)
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 40)
2 325 000 FEET
2 340 000 FEET
685 000 FEET
680 000 FEET
H O W A R D
C E N T E R
QUARRY
GRAVEL PIT
water
West Branch
Turkey River
Turkey
Branch
West
20
21
22
23
26
27
28
29

N


(Joins sheet 27)
R. 12 W.
R. 11 W.
2 355 000 FEET
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 41)
2 345 000 FEET
680 000 FEET
685 000 FEET
T. 99 N.
H O W A R D
C E N T E R
V E R N O N
S P R I N G S
CHICAGO
MILWAUKEE
ST PAUL
AND
PACIFIC
North Branch
West Br.
Turkey River
water
G.P.
24
19
20
21
25
30
29
28

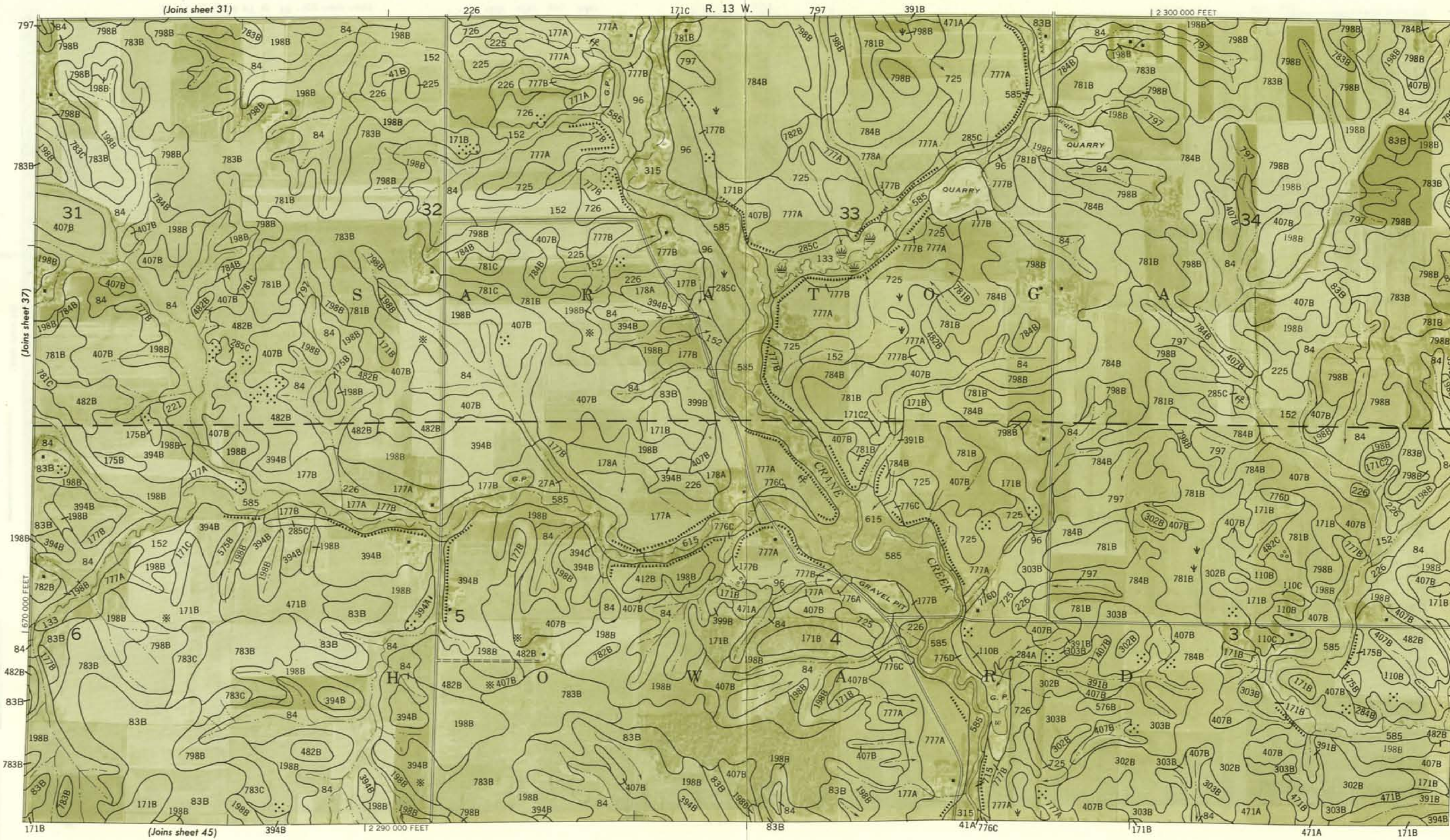

35
N
2 360 000 FEET
R. 11 W.
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 42)
T. 99 N.
685 000 FEET
680 000 FEET
2 375 000 FEET
WINNESHIEK COUNTY
VERNON SPRINGS
CRESCO
(county seat)
CHICAGO
MILWAUKEE
ST. PAUL
AND
PACIFIC
Airfield
QUARRY
BORROW PIT
G.P.
B.P.
21
22
23
24
25
26
27
28

N

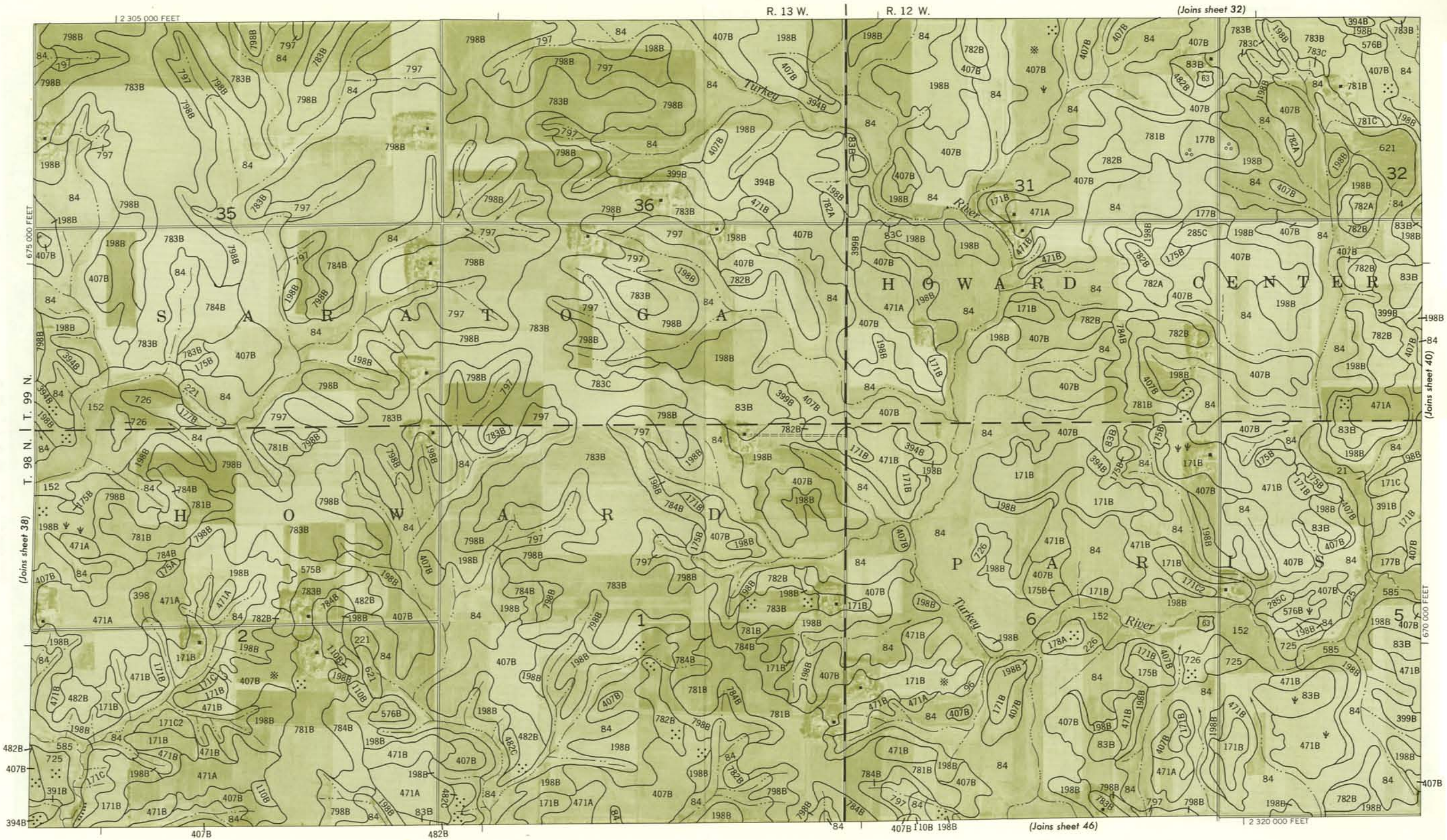

(Joins sheet 29)
R. 14 W.
2 265 000 FEET
Riceville
31
32
33
J A M E S T O W N
CHICAGO AND NORTH WESTERN
MITCHELL COUNTY
T. 99 N.
T. 98 N.
675 000 FEET
670 000 FEET
(Joins sheet 37)
6
5
4
2 250 000 FEET
(Joins sheet 43)


(Joins sheet 30)
R. 14 W.
R. 13 W.
2 270 000 FEET
675 000 FEET
670 000 FEET
2 285 000 FEET
T. 99 N.
T. 98 N.
(Joins sheet 36)
(Joins sheet 38)
(Joins sheet 44)
JAMESTOWN
AFTON
SARATOGA
HOWARD
Little Wapsipinicon River
34
35
36
31
3
2
1
6

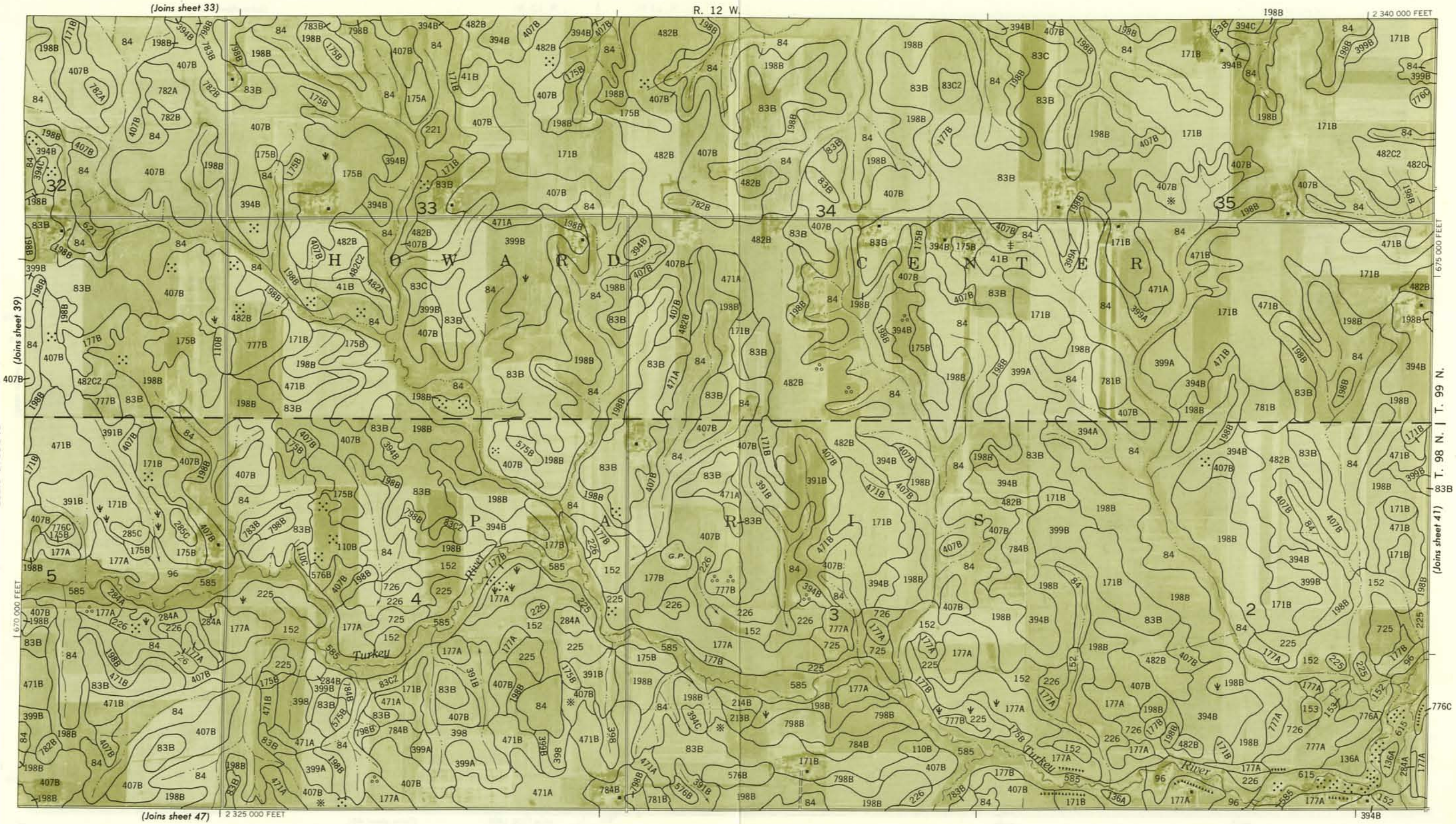
N

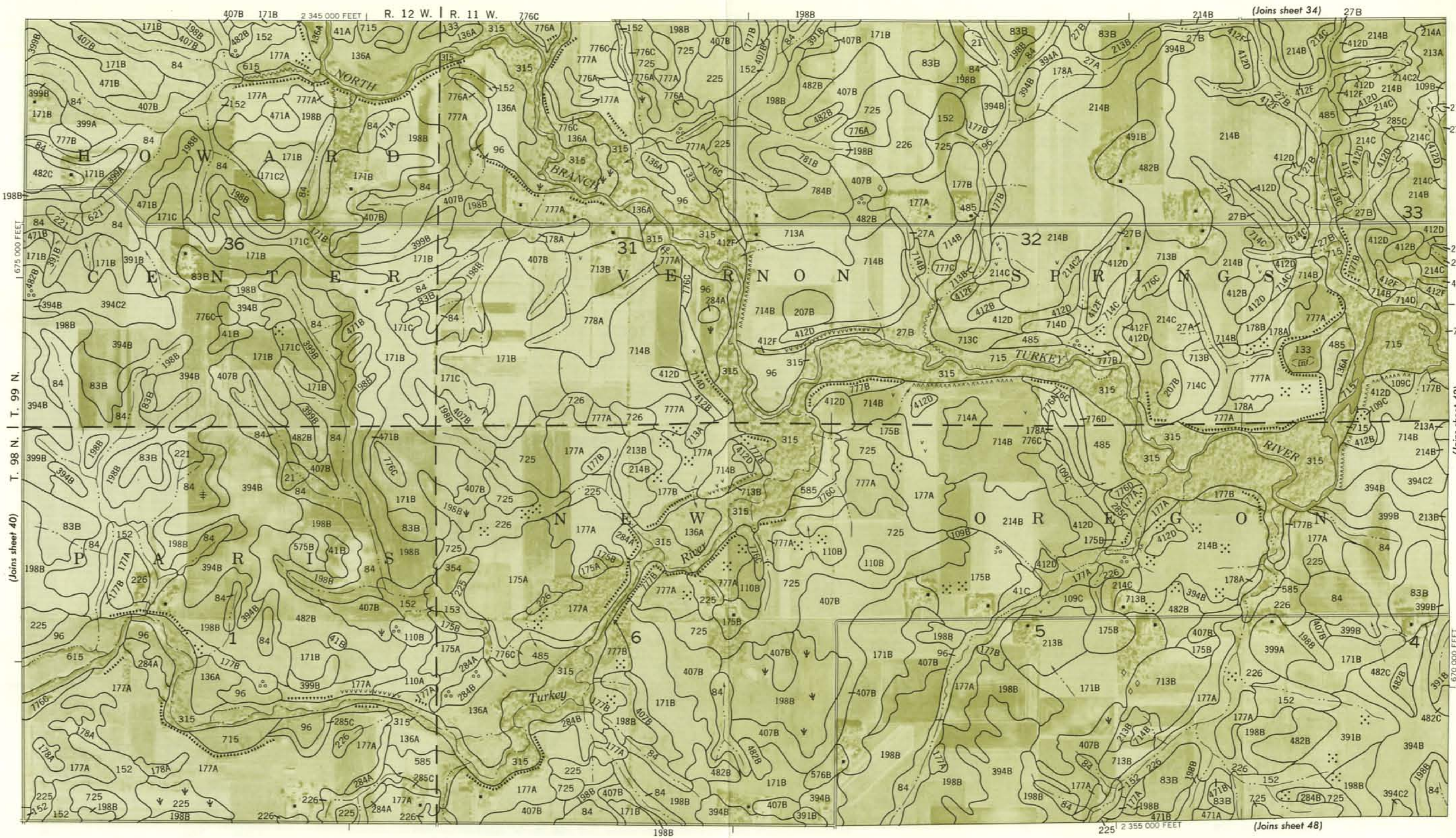

(Joins sheet 31)
R. 13 W.
2 300 000 FEET
675 000 FEET
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 45)
2 290 000 FEET
670 000 FEET
T. 99 N.
T. 98 N.
31
32
33
34
6
5
4
3
S A R A T O G A
H O W A R D
CRANE CREEK
QUARRY
GRAVEL PIT
G.P.
Water

N

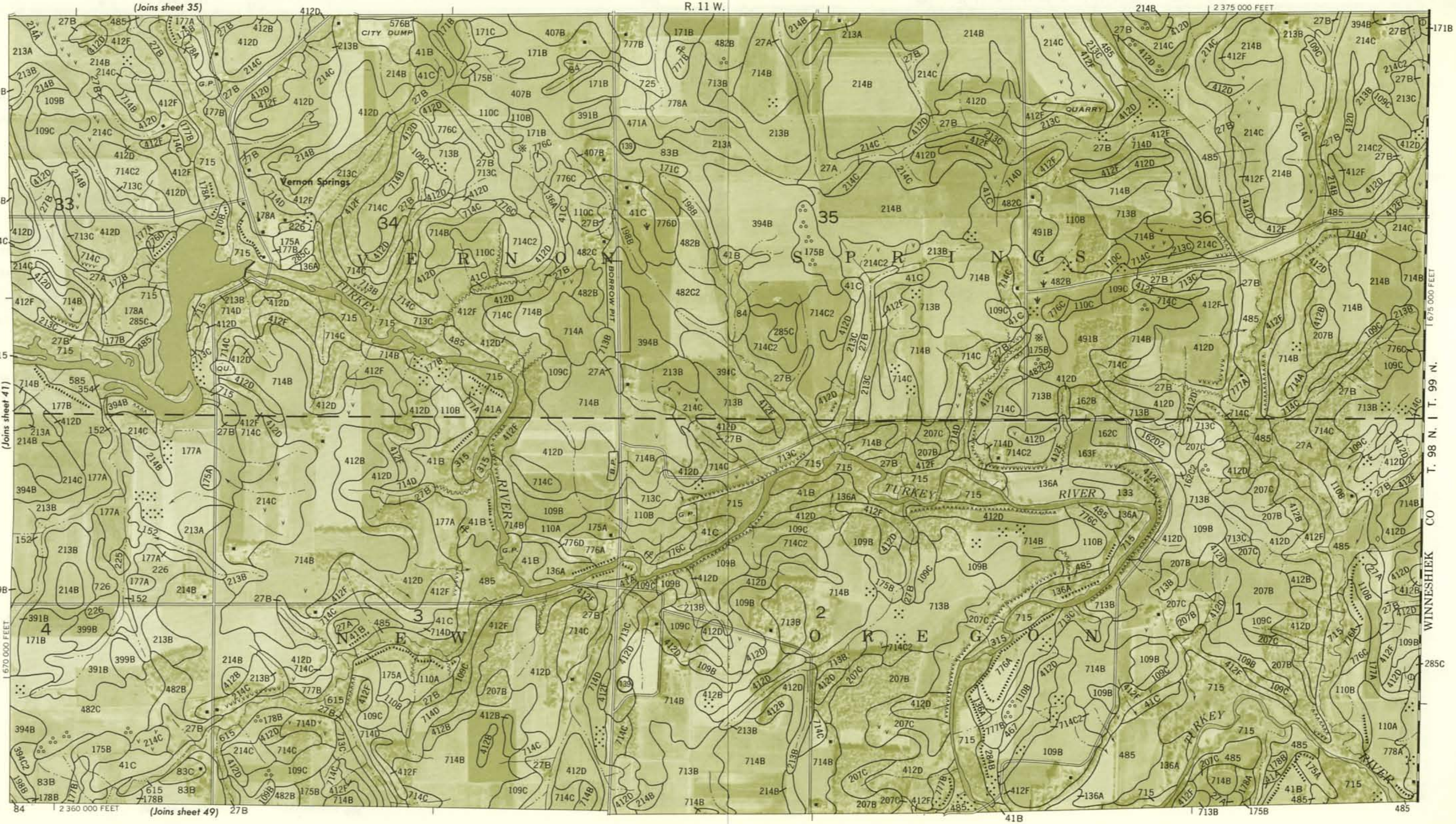

R. 13 W.
R. 12 W.
(Joins sheet 32)
(Joins sheet 40)
(Joins sheet 46)
(Joins sheet 38)
2 305 000 FEET
2 320 000 FEET
675 000 FEET
670 000 FEET
T. 99 N.
T. 98 N.
S A R A T O G A
H O W A R D C E N T E R
H O W A R D
P A R I S
Turkey River
Turkey River
35
36
31
32
2
1
6
5
63

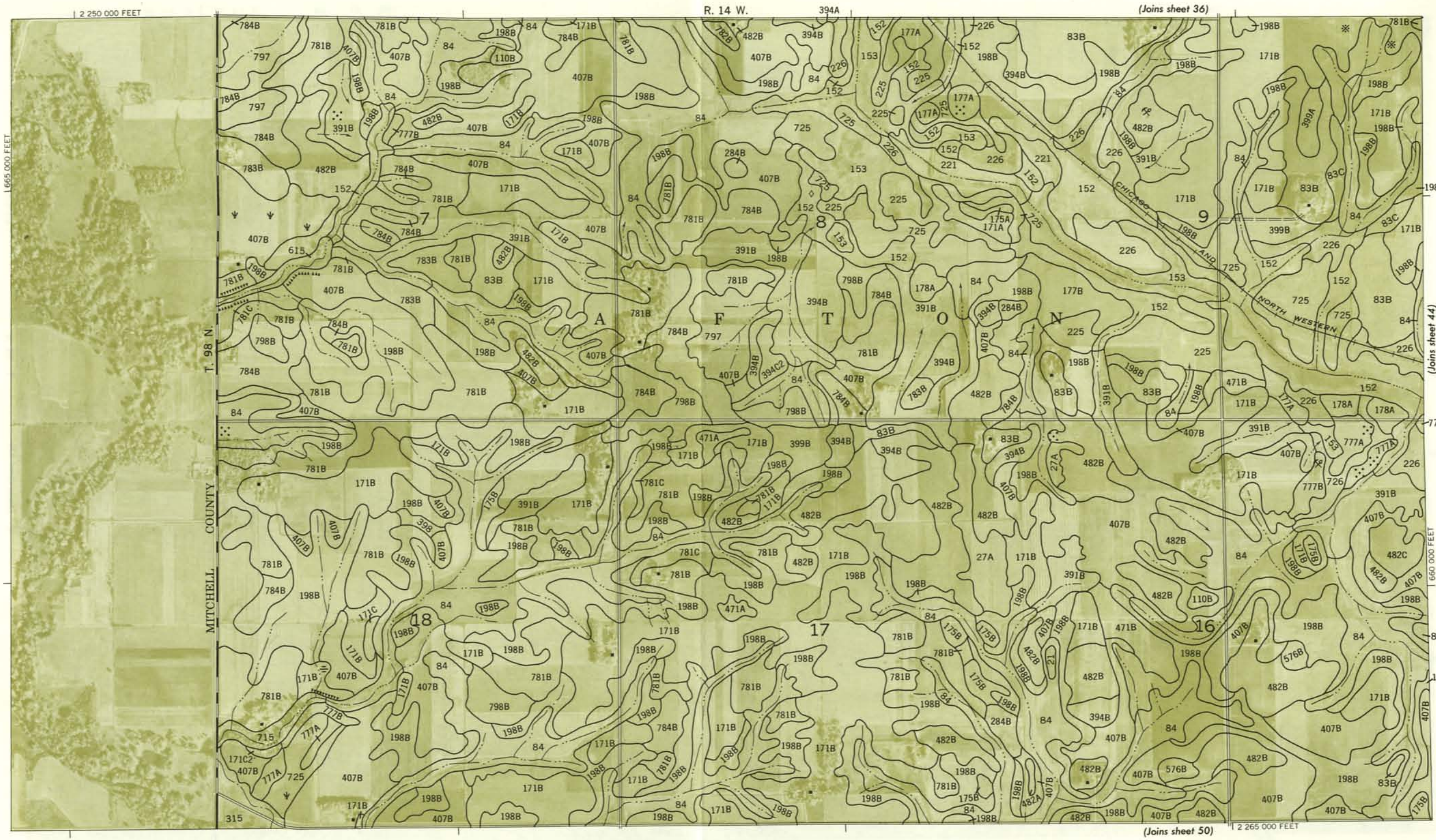
N


(Joins sheet 33)
R. 12 W.
2 340 000 FEET
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 47)
2 325 000 FEET
675 000 FEET
670 000 FEET
T. 99 N.
T. 98 N.
H O W A R D C E N T E R
P A R I S
Turkey River
G.P.
32
33
34
35
5
4
3
2


N
R. 12 W.
R. 11 W.
2 345 000 FEET
(Joins sheet 34)
(Joins sheet 42)
(Joins sheet 48)
(Joins sheet 40)
T. 99 N.
T. 98 N.
675 000 FEET
670 000 FEET
2 355 000 FEET
HOWARD
CENTER
PRAIRIE
VERNON SPRINGS
NEW OREGON
NORTH BRANCH
TURKEY RIVER
Turkey River
36
31
32
33
1
6
5
4

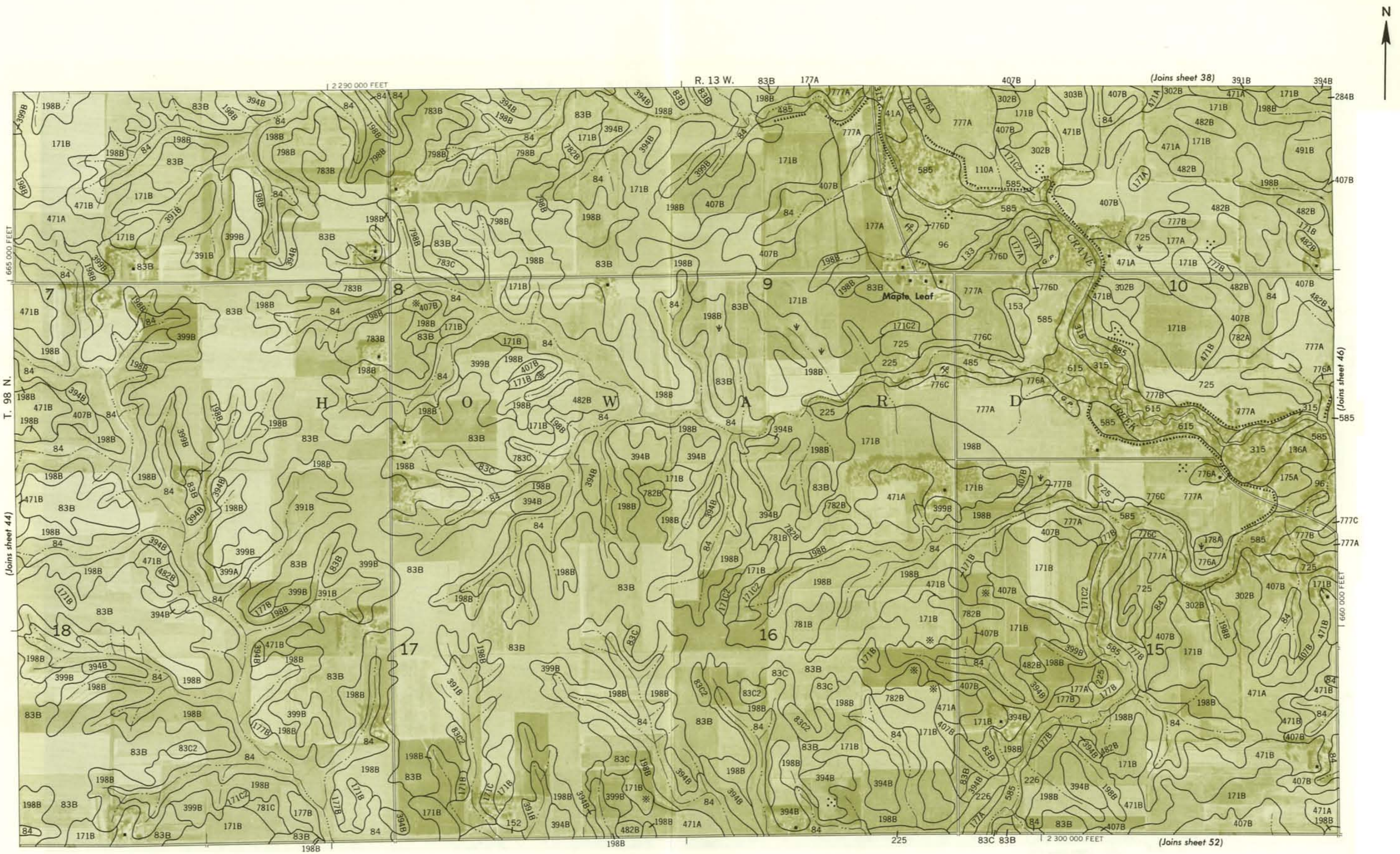
N


(Joins sheet 35)
R. 11 W.
2 375 000 FEET
CITY DUMP
QUARRY
Vernon Springs
BORROW PIT
V E R N O N   S P R I N G S
TURKEY
RIVER
33
34
35
36
4
3
2
1
N E W
O R E G O N
T. 99 N.
T. 98 N.
WINNESHIEK CO
(Joins sheet 41)
675 000 FEET
670 000 FEET
2 360 000 FEET
(Joins sheet 49)


N
R. 14 W.
T. 98 N.
MITCHELL COUNTY
(Joins sheet 36)
(Joins sheet 44)
(Joins sheet 50)
2 250 000 FEET
2 265 000 FEET
665 000 FEET
660 000 FEET
A F T O N
CHICAGO AND NORTH WESTERN
7
8
9
16
17
18

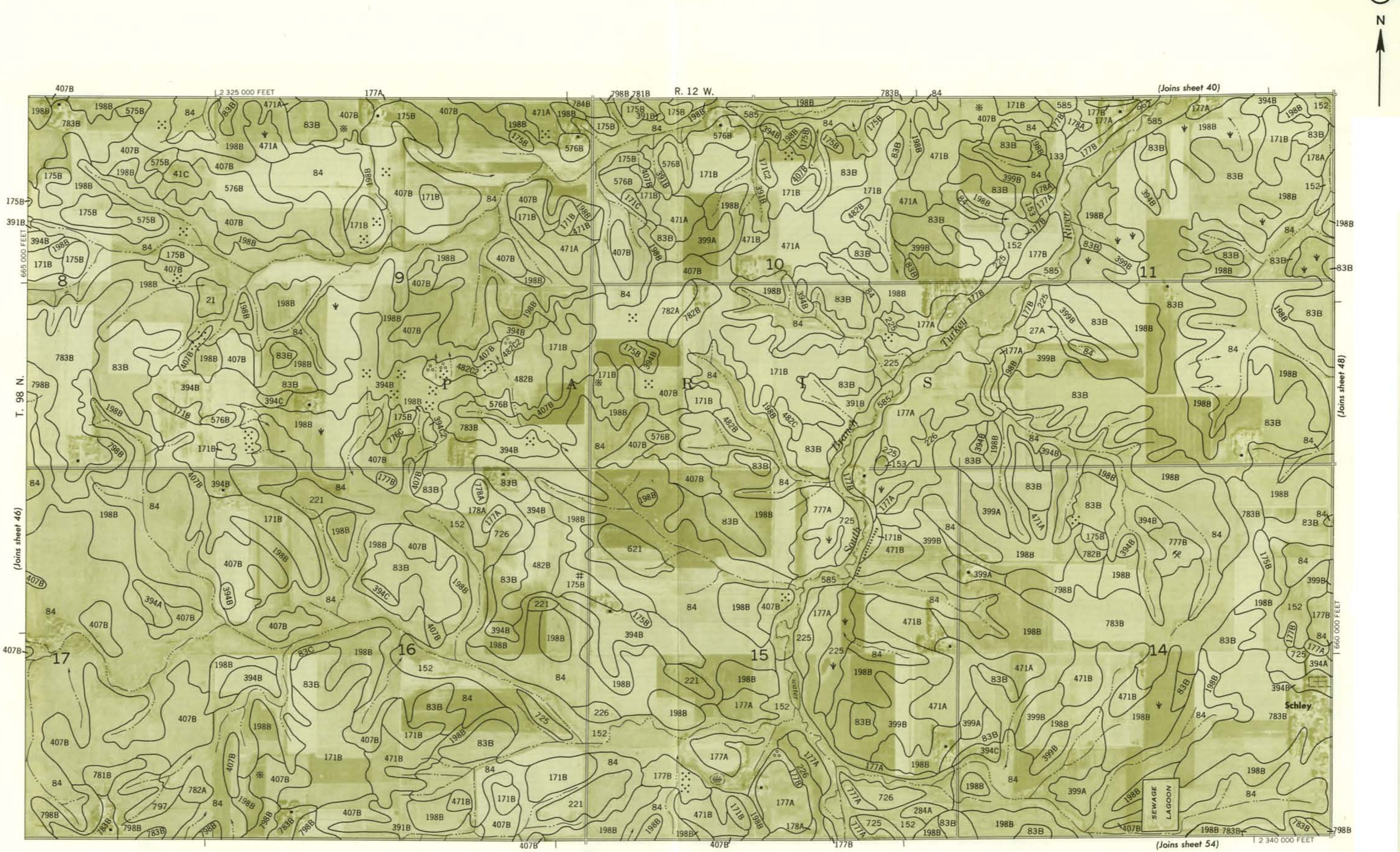
HOWARD COUNTY, IOWA — SHEET NUMBER 44

N


N
R. 13 W.
T. 98 N.
(Joins sheet 38)
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 52)
2 290 000 FEET
2 300 000 FEET
665 000 FEET
660 000 FEET
Maple Leaf
CRANE CREEK
H O W A R D
7
8
9
10
15
16
17
18

HOWARD COUNTY, IOWA — SHEET NUMBER 46

N

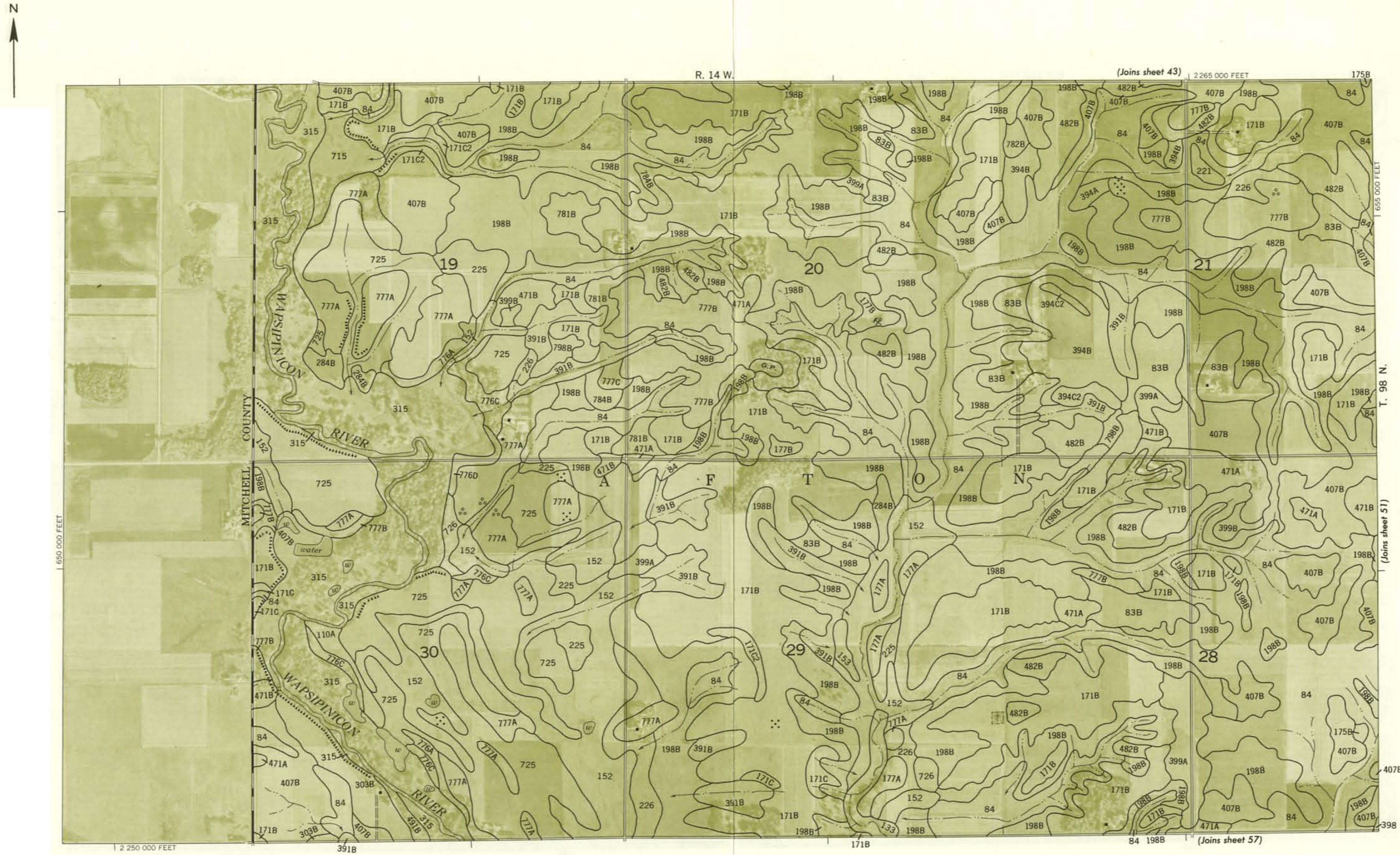

N
(Joins sheet 40)
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 54)
R. 12 W.
T. 98 N.
2 325 000 FEET
2 340 000 FEET
665 000 FEET
660 000 FEET
Turkey River
South Branch
Schley
SEWAGE LAGOON

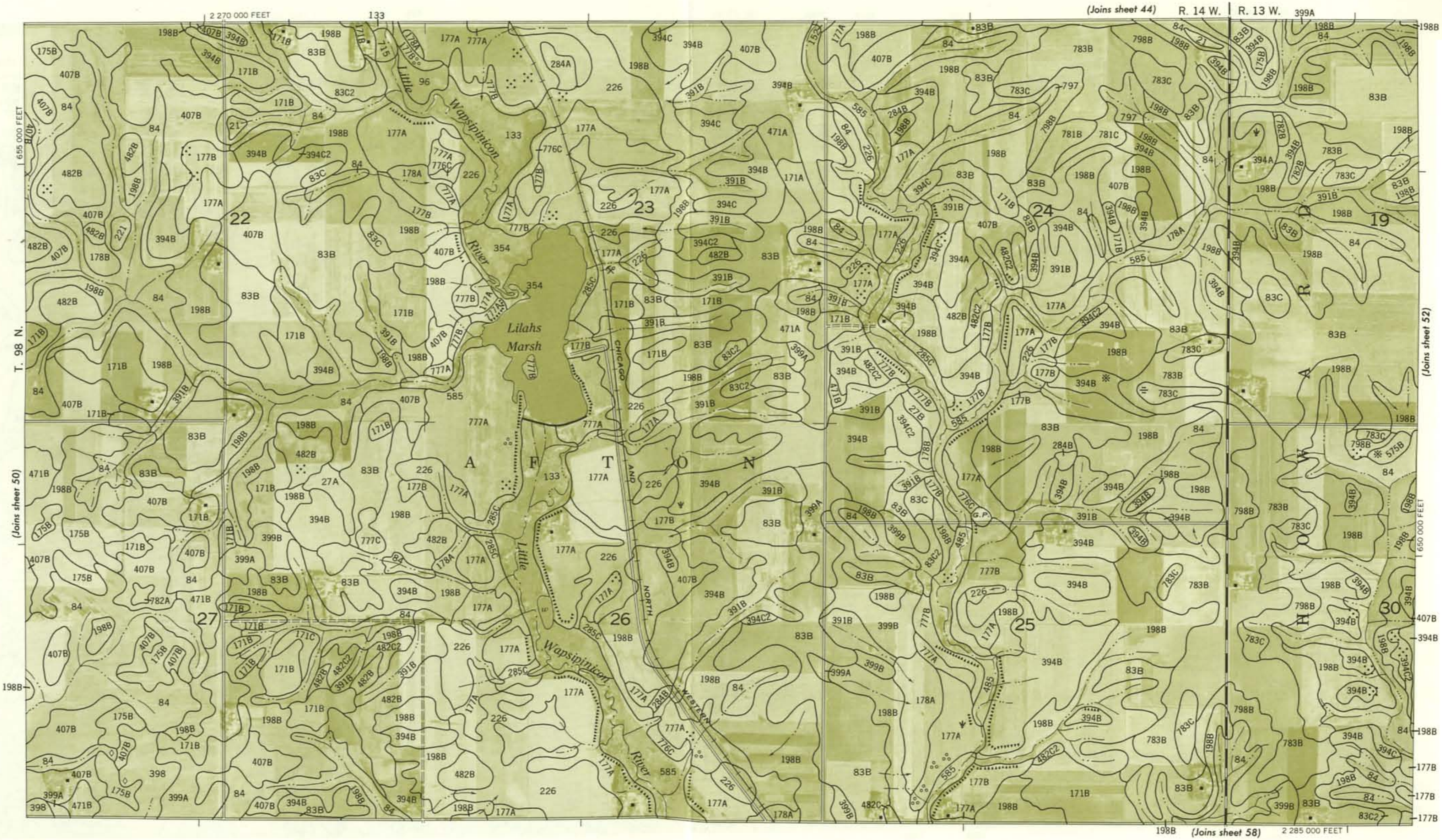
N


(Joins sheet 41)
R.12 W.
R.11 W.
2 355 000 FEET
665 000 FEET
(Joins sheet 47)
T. 98 N.
(Joins sheet 49)
660 000 FEET
(Joins sheet 55)
2 345 000 FEET
P A R I S
N E W
O R E G O N
12
7
8
9
13
18
17
16
Schley
Turkey River
Little Turkey

N


(Joins sheet 42)
R. 11 W.
T. 98 N.
(Joins sheet 48)
(Joins sheet 56)
WINNESHIEK COUNTY
TURKEY RIVER
N E W   O R E G O N
2 360 000 FEET
2 375 000 FEET
665 000 FEET
660 000 FEET
9
10
11
12
13
14
15
16

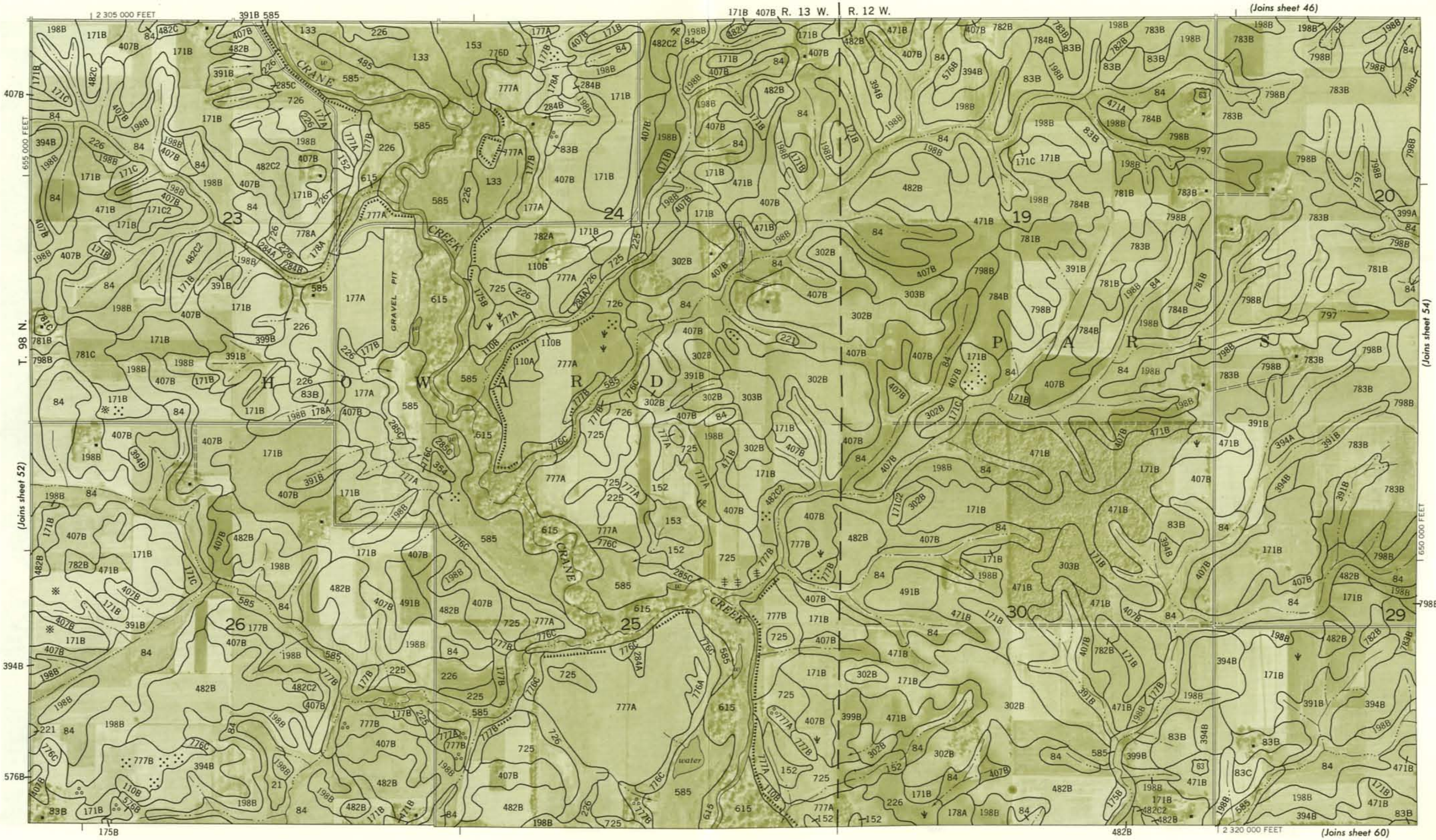

N
R. 14 W.
(Joins sheet 43)
2 265 000 FEET
655 000 FEET
T. 98 N.
(Joins sheet 51)
(Joins sheet 57)
650 000 FEET
2 250 000 FEET
MITCHELL COUNTY
WAPSIPINICON RIVER
WAPSIPINICON RIVER
A F T O N
19
20
21
30
29
28


N
(Joins sheet 44)
R. 14 W.
R. 13 W.
(Joins sheet 52)
(Joins sheet 50)
(Joins sheet 58)
2 270 000 FEET
2 285 000 FEET
655 000 FEET
650 000 FEET
T. 98 N.
Lilahs
Marsh
Little
Wapsipinicon
River
CHICAGO
AND
NORTH
WESTERN
A F T O N
H O W A R D
22
23
24
19
27
26
25
30
G.P.

N


(Joins sheet 45)
R. 13 W.
2 300 000 FEET
655 000 FEET
(Joins sheet 51)
(Joins sheet 53)
T. 98 N.
650 000 FEET
(Joins sheet 59)
2 290 000 FEET
H O W A R D
19
20
21
22
30
29
28
27
Mead Creek

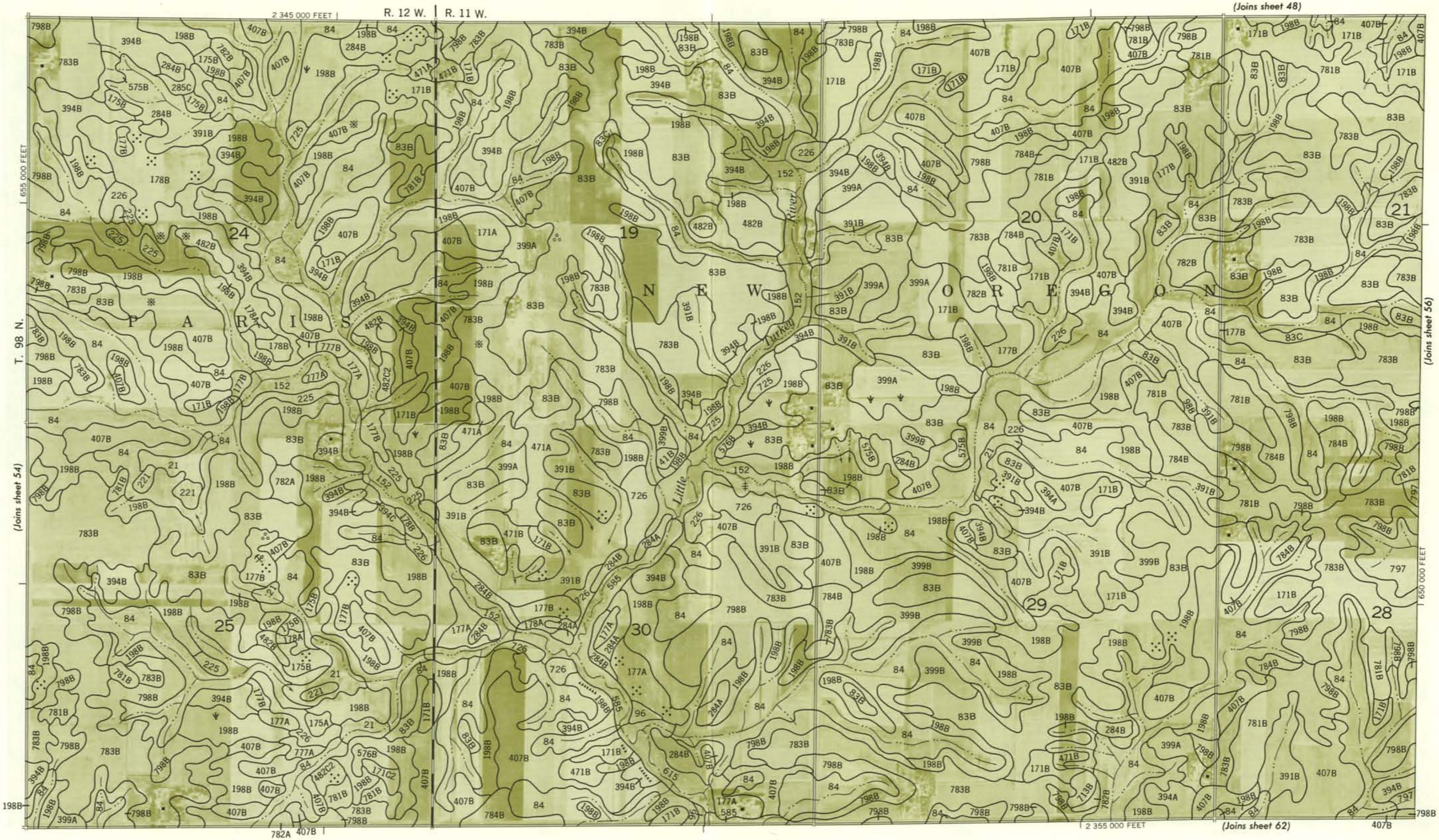
N


(Joins sheet 46)
2 305 000 FEET
R. 13 W.
R. 12 W.
655 000 FEET
T. 98 N.
(Joins sheet 52)
CRANE
CREEK
GRAVEL PIT
H O W A R D
P A R I S
(Joins sheet 54)
650 000 FEET
water
2 320 000 FEET
(Joins sheet 60)
23
24
19
20
26
25
30
29

N

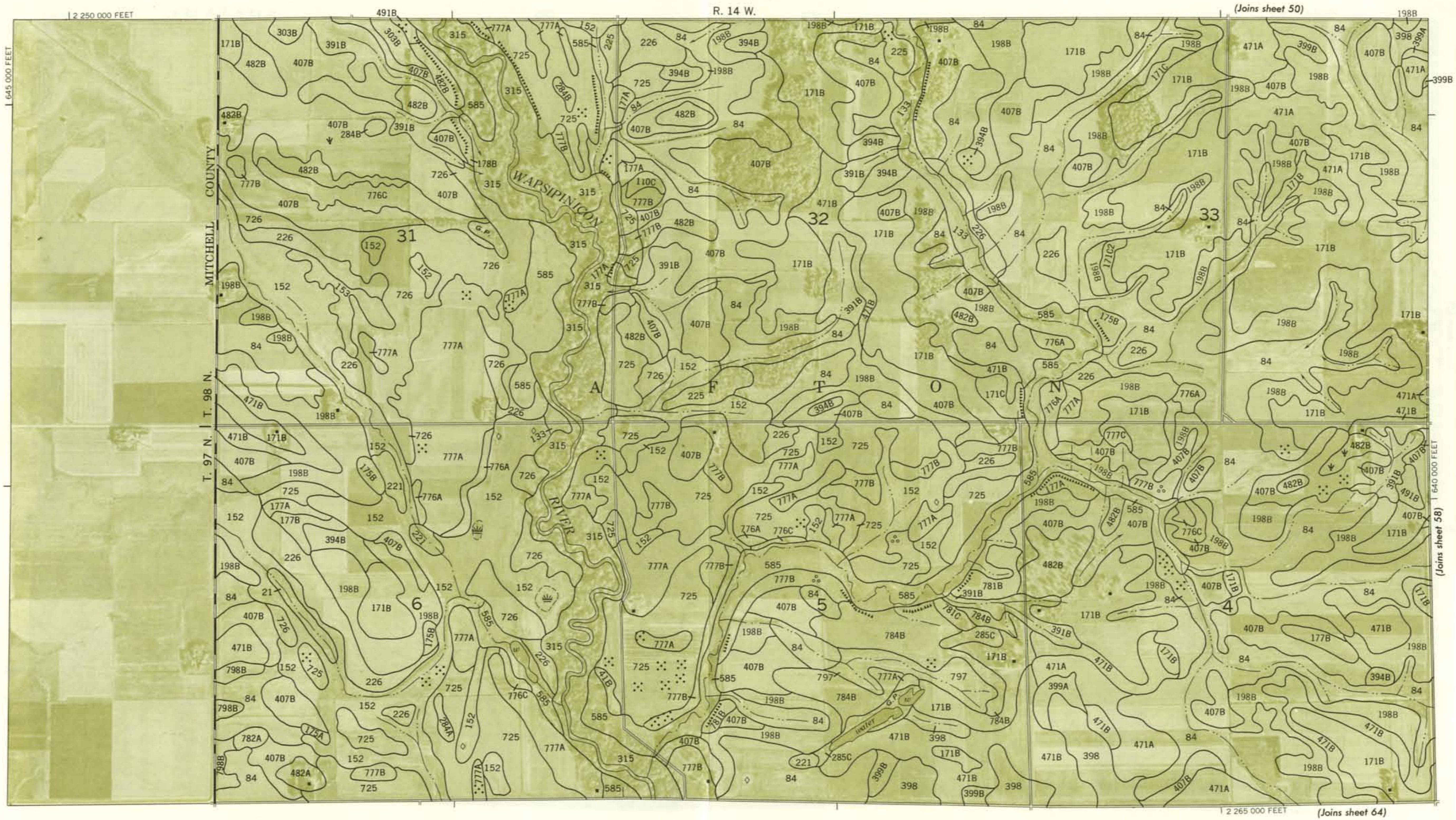

(Joins sheet 47)
R. 12 W.
2 340 000 FEET
655 000 FEET
T. 98 N.
(Joins sheet 55)
(Joins sheet 53)
650 000 FEET
(Joins sheet 61)
2 325 000 FEET
South Branch Turkey River
P A R I S
20
21
22
23
26
27
28
29

N

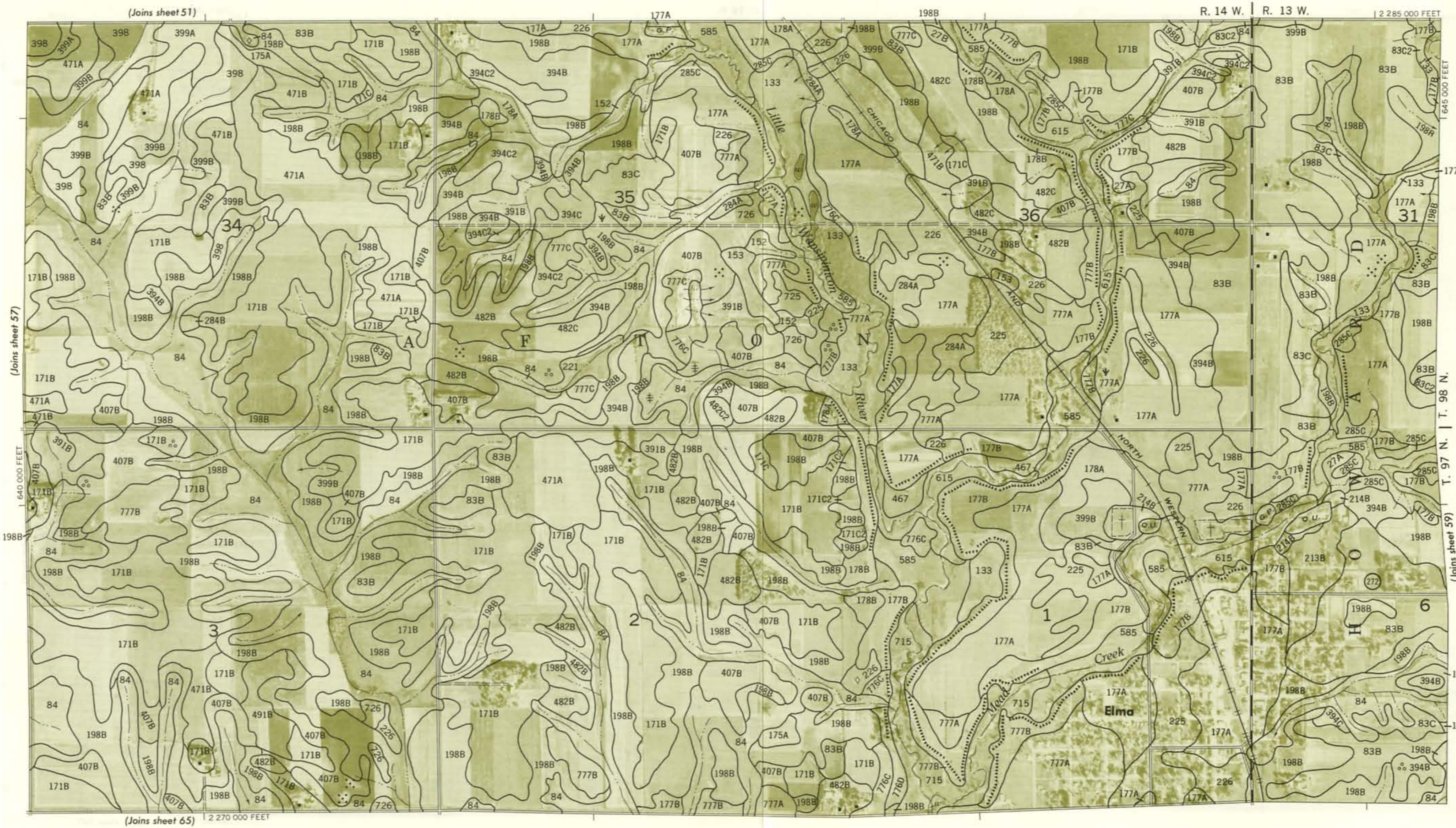

(Joins sheet 48)
(Joins sheet 54)
(Joins sheet 56)
(Joins sheet 62)
R. 12 W.
R. 11 W.
T. 98 N.
2 345 000 FEET
2 355 000 FEET
655 000 FEET
650 000 FEET
P A R I S
N E W O R E G O N
Little Turkey River
24
19
20
21
25
30
29
28

N


(Joins sheet 49)
R. 11 W.
2 375 000 FEET
655 000 FEET
T. 98 N.
WINNESHIEK COUNTY
(Joins sheet 55)
650 000 FEET
2 360 000 FEET
(Joins sheet 63)
NEW OREGON
Bohemian Creek
21
22
23
24
25
26
27
28

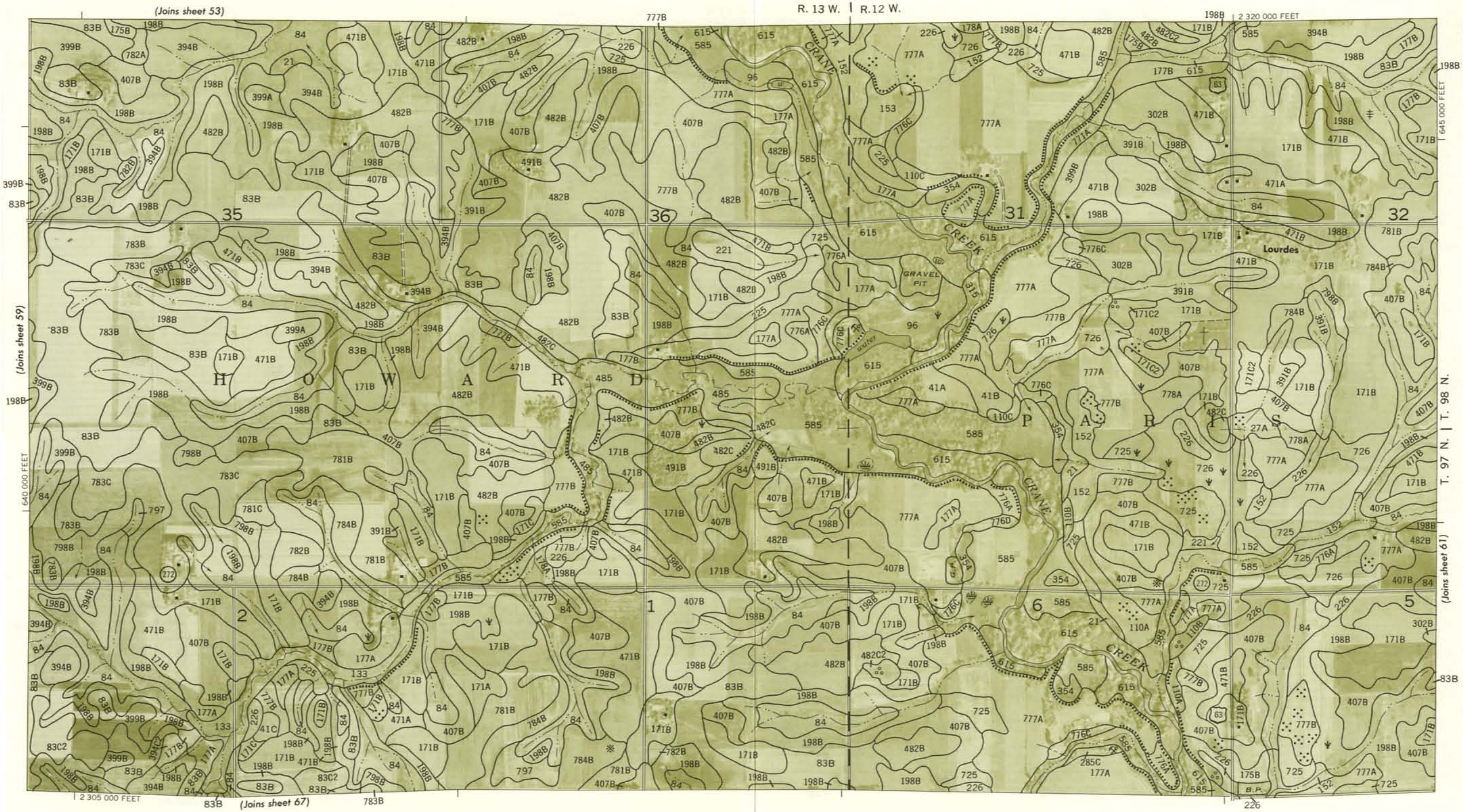

57
N
(Joins sheet 50)
(Joins sheet 58)
(Joins sheet 64)
R. 14 W.
T. 98 N.
T. 97 N.
MITCHELL COUNTY
2 250 000 FEET
645 000 FEET
640 000 FEET
2 265 000 FEET
WAPSIPINICON
RIVER
A F T O N
31
32
33
6
5
4

N


(Joins sheet 51)
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 65)
R. 14 W.
R. 13 W.
T. 98 N.
T. 97 N.
2 285 000 FEET
645 000 FEET
640 000 FEET
2 270 000 FEET
34
35
36
31
3
2
1
6
A F T O N
H O W A R D
Little Wapsipinicon River
CHICAGO AND NORTH WESTERN
Elma
Creek


N
R. 13 W.
(Joins sheet 52)
(Joins sheet 60)
(Joins sheet 66)
(Joins sheet 58)
T. 98 N.
T. 97 N.
2 290 000 FEET
2 300 000 FEET
645 000 FEET
640 000 FEET
HOWARD
Mead Creek
Elk Creek
31
32
33
34
6
5
4
3

N


(Joins sheet 53)
R. 13 W. | R.12 W.
2 320 000 FEET
645 000 FEET
(Joins sheet 59)
640 000 FEET
(Joins sheet 61)
T. 97 N. | T. 98 N.
2 305 000 FEET
(Joins sheet 67)
HOWARD
PARIS
CRANE CREEK
CRANE CREEK
GRAVEL PIT
Lourdes
35
36
31
32
2
1
6
5

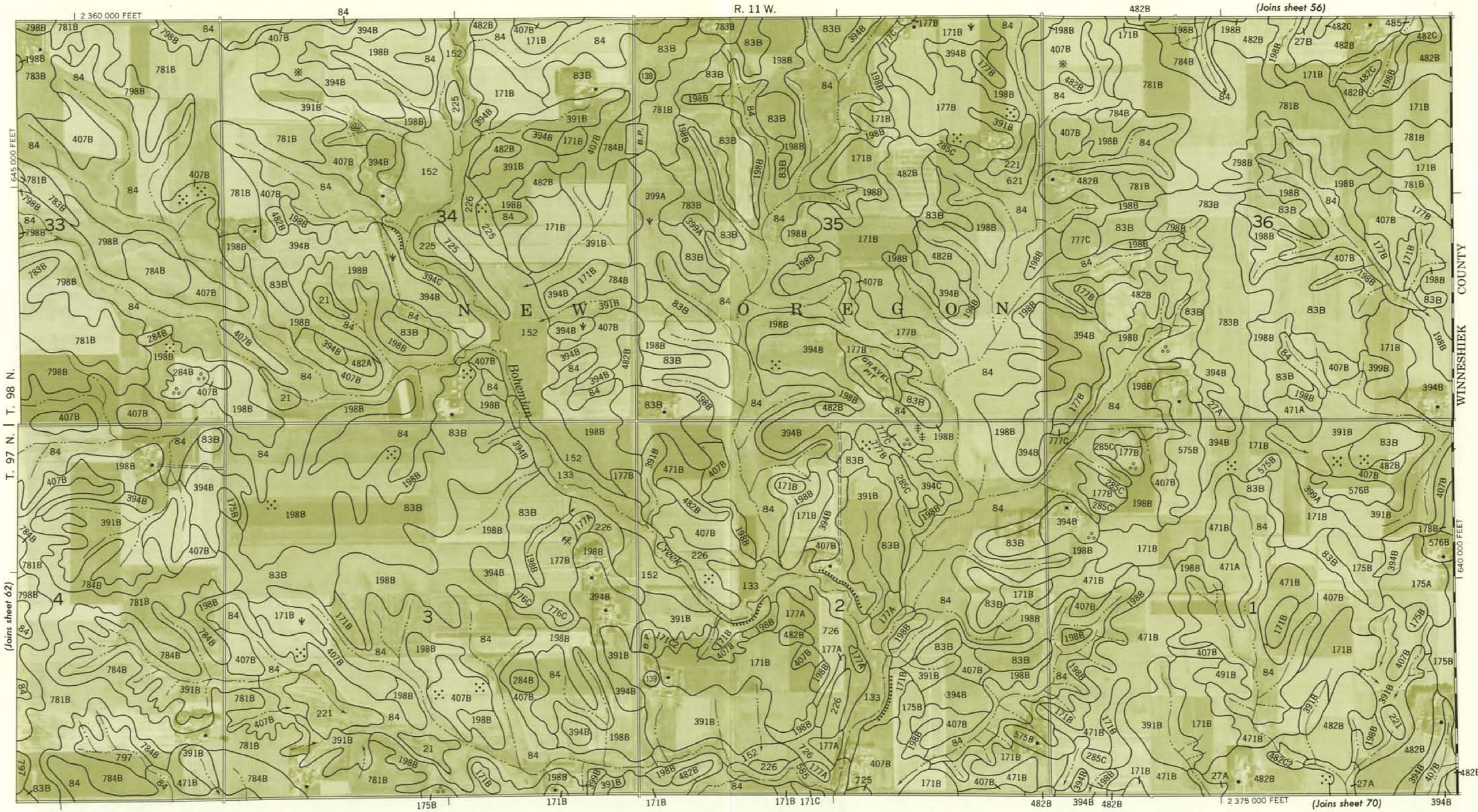
N

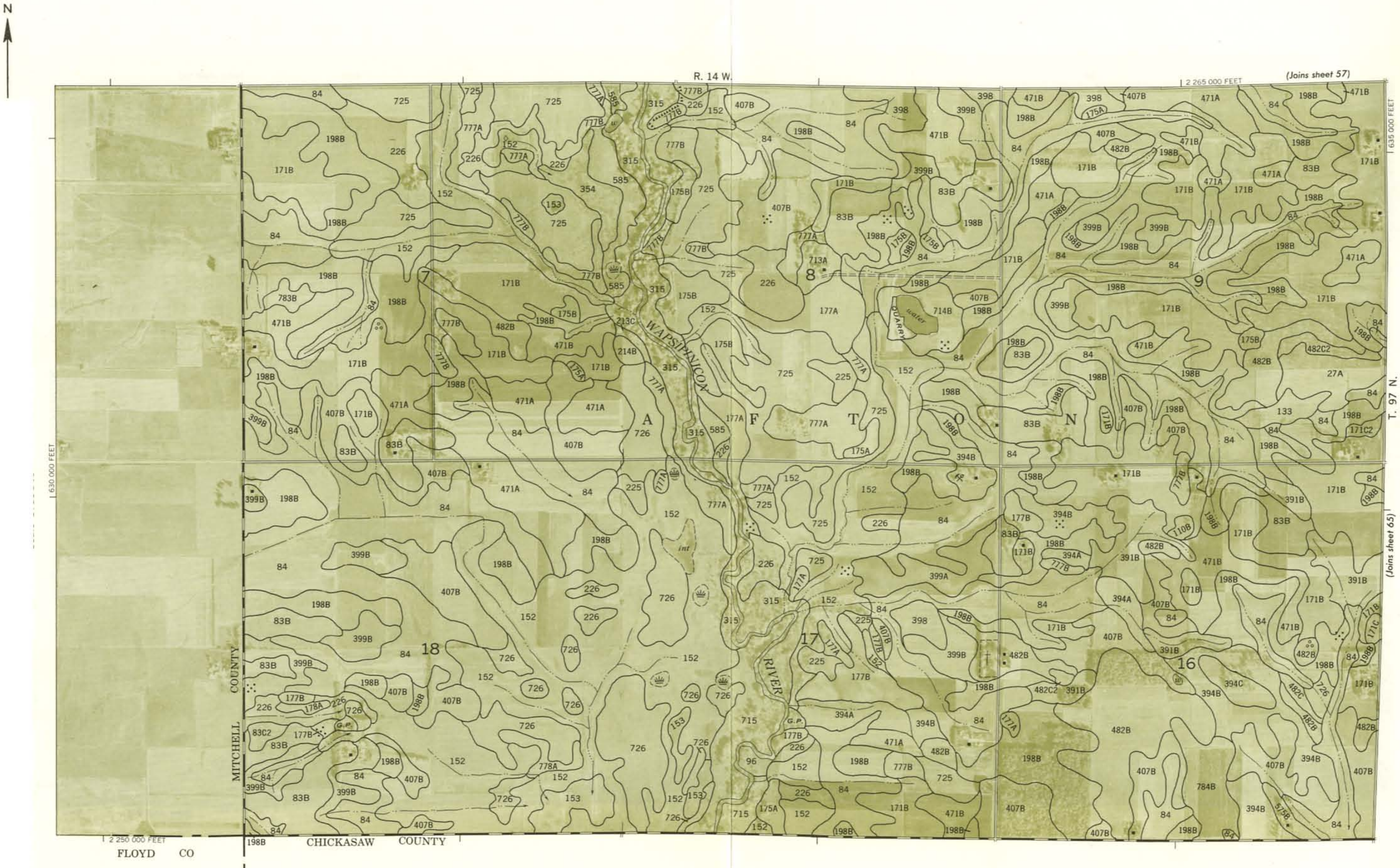

2 325 000 FEET
R. 12 W.
(Joins sheet 54)
645 000 FEET
T. 98 N.
T. 97 N.
(Joins sheet 60)
(Joins sheet 62)
640 000 FEET
(Joins sheet 68)
2 340 000 FEET
32
33
34
35
5
4
3
2
P
A
R
I
S

N

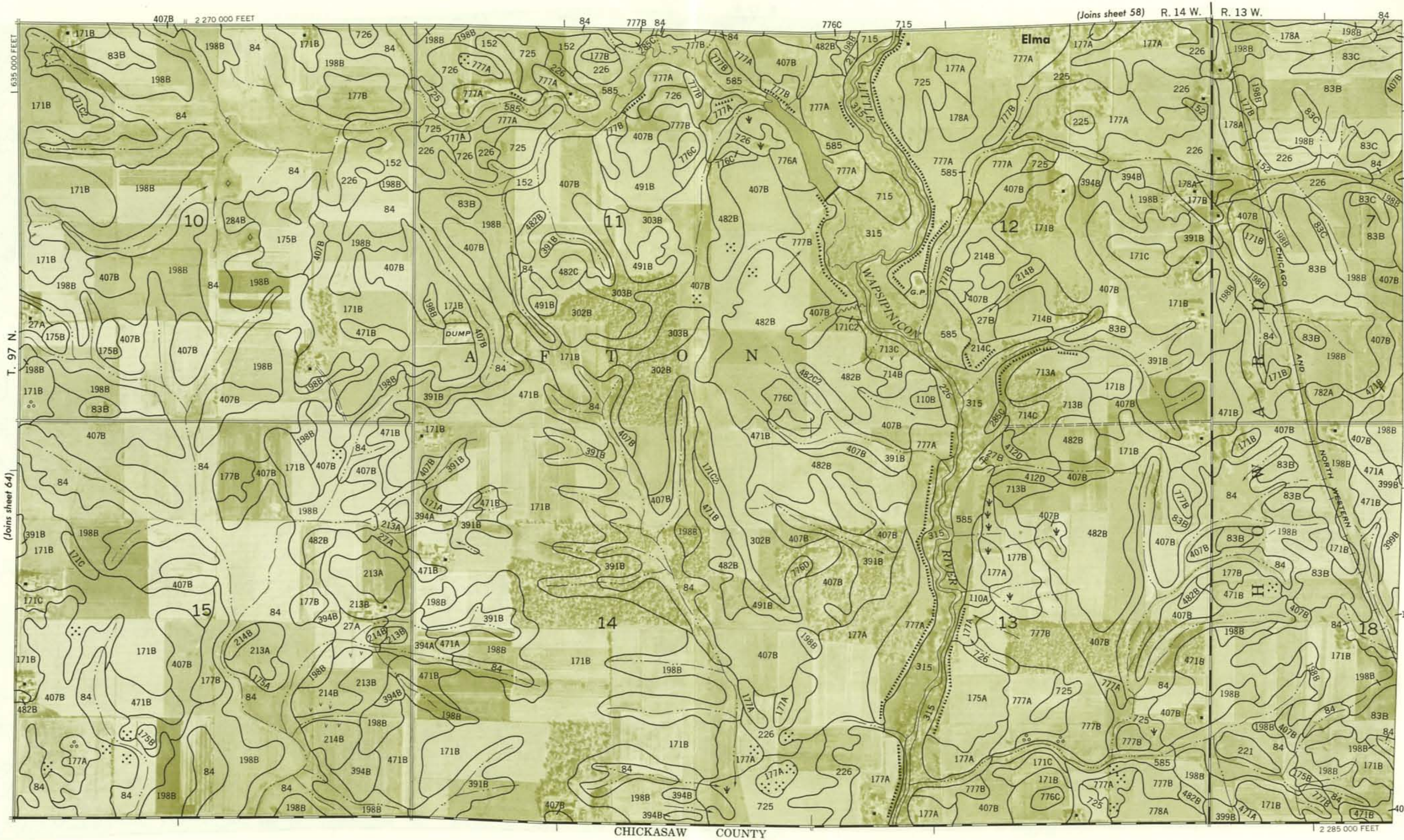

(Joins sheet 55)
R. 12 W.
R. 11 W.
2 355 000 FEET
645 000 FEET
640 000 FEET
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 69)
2 345 000 FEET
T. 98 N.
T. 97 N.
P A R I S
N E W
O R E G O N
Turkey
River
Little
36
31
32
33
1
6
5
4

N

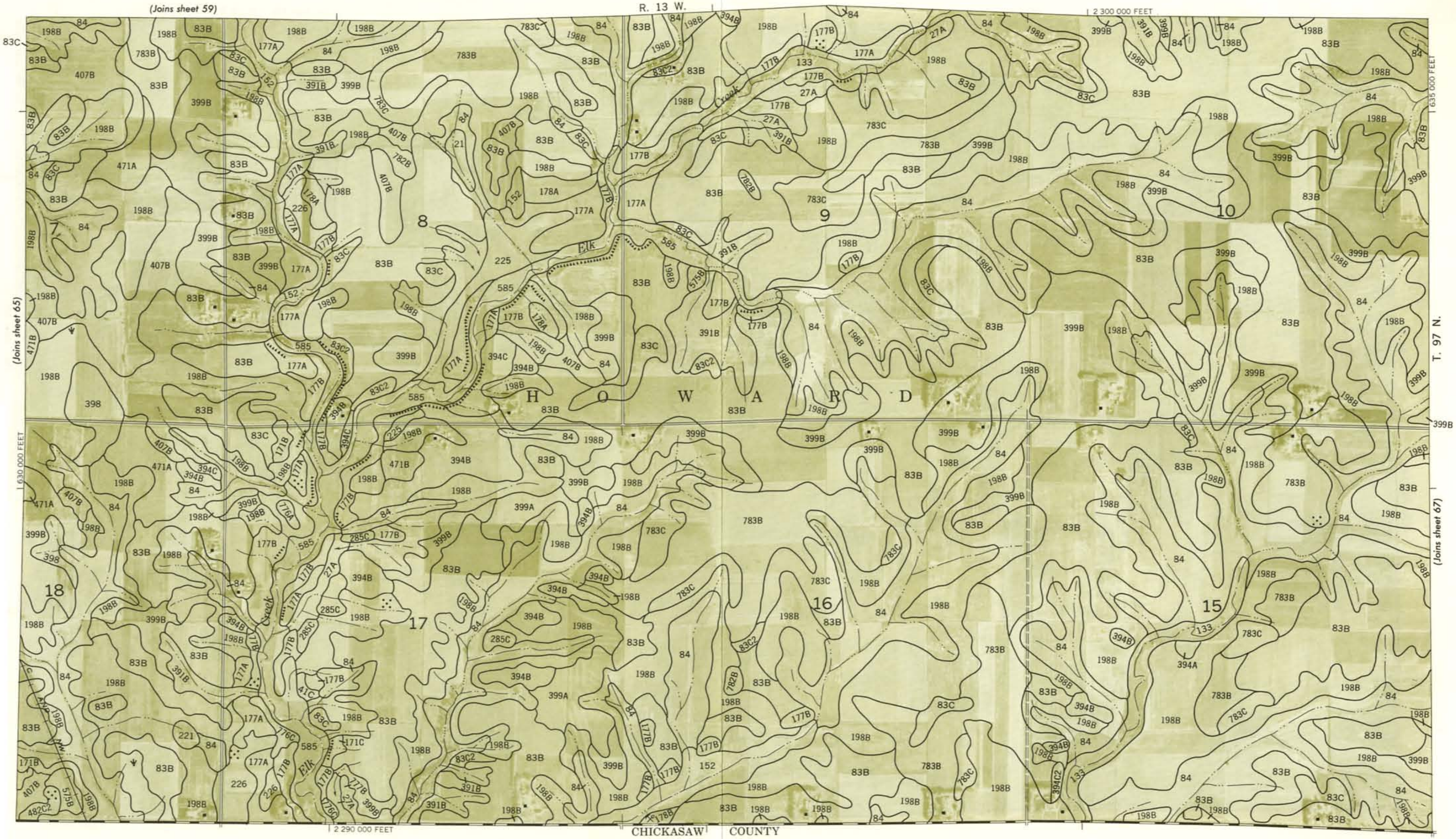

R. 11 W.
(Joins sheet 56)
2 360 000 FEET
645 000 FEET
T. 98 N.
T. 97 N.
(Joins sheet 62)
33
34
35
36
4
3
2
1
N E W O R E G O N
Bohemian Creek
GRAVEL PIT
B.P.
WINNESHIEK COUNTY
640 000 FEET
2 375 000 FEET
(Joins sheet 70)

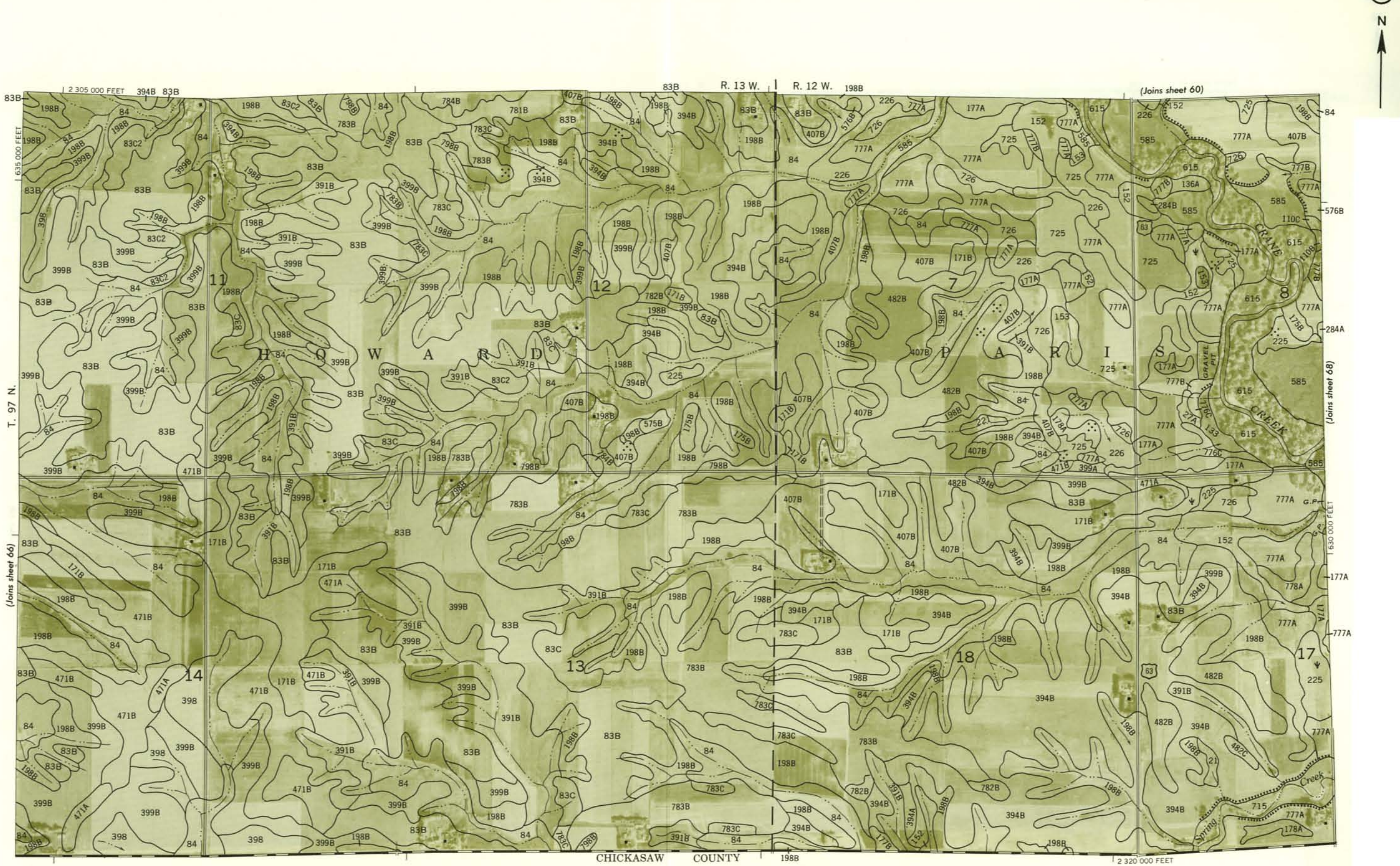

N
R. 14 W.
(Joins sheet 57)
2 265 000 FEET
635 000 FEET
630 000 FEET
T. 97 N.
(Joins sheet 65)
WAPSIPINICON
RIVER
A F T O N
7
8
9
16
17
18
QUARRY
water
G.P.
MITCHELL COUNTY
CHICKASAW COUNTY
FLOYD CO
2 250 000 FEET

N


2 270 000 FEET
635 000 FEET
(Joins sheet 58)
R. 14 W.
R. 13 W.
Elma
LITTLE
WAPSIPINICON
RIVER
A F T O N
H O W A R D
CHICAGO AND NORTH WESTERN
T. 97 N.
(Joins sheet 64)
(Joins sheet 66)
630 000 FEET
DUMP
G.P.
10
11
12
7
15
14
13
18
CHICKASAW COUNTY
2 285 000 FEET

N


(Joins sheet 59)
R. 13 W.
2 300 000 FEET
635 000 FEET
T. 97 N.
(Joins sheet 67)
(Joins sheet 65)
630 000 FEET
2 290 000 FEET
CHICKASAW COUNTY
H O W A R D
Elk Creek
7
8
9
10
15
16
17
18


67
N
(Joins sheet 60)
(Joins sheet 66)
(Joins sheet 68)
R. 13 W.
R. 12 W.
T. 97 N.
2 305 000 FEET
635 000 FEET
630 000 FEET
2 320 000 FEET
H O W A R D
P A R I S
CRANE CREEK
Spring Creek
GRAVEL PIT
CHICKASAW COUNTY

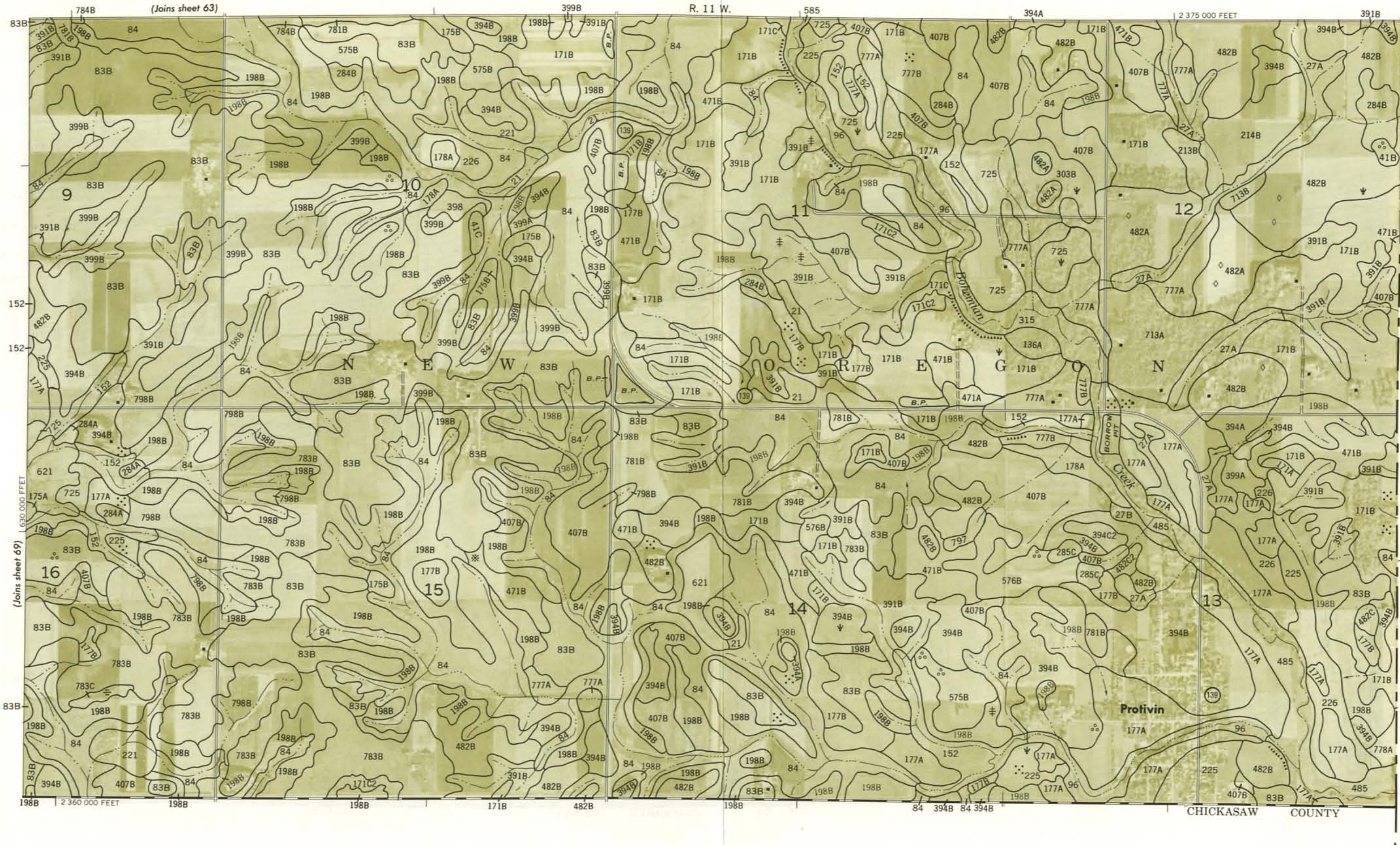
N


(Joins sheet 61)
R. 12 W.
2 340 000 FEET
635 000 FEET
T. 97 N.
(Joins sheet 67)
(Joins sheet 69)
630 000 FEET
2 325 000 FEET
P A R I S
CRANE CREEK
Spring
CHICKASAW COUNTY

N


R. 12 W.
R. 11 W.
2 345 000 FEET
(Joins sheet 62)
635 000 FEET
T. 97 N.
(Joins sheet 68)
(Joins sheet 70)
630 000 FEET
P A R I S
N E W
O R E G O N
Little
Turkey
River
12
7
8
9
13
18
17
16
CHICKASAW
COUNTY
2 355 000 FEET

N


(Joins sheet 63)
R. 11 W.
2 375 000 FEET
635 000 FEET
630 000 FEET
T. 97 N.
(Joins sheet 69)
N E W O R E G O N
Bohemian
Creek
BORROW PIT
B.P.
Protivin
WINNESHIEK COUNTY
CHICKASAW COUNTY
2 360 000 FEET